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# THE NATIONAL ACADEMY OF SCIENCES[1]

## ADDRESS OF THE PRESIDENT[2]

THE academy has adhered very consistently since its incorporation to the principle that the primary consideration for membership is convincing evidence, by scholarly character and productiveness, of devotion to the fundamental principles of science and the scientific way of knowledge, which are the sources of the discoveries and inventions that have transformed the social and economic conditions of modern life. There is no danger that we should depart from these principles. But it should be widely known that we fully recognize the social, economic and national responsibilities that rest upon us, and that we are making every effort to discharge these responsibilities. The academy occupies a very special position of responsibility in the relations between science and public affairs.

[1] Meeting in Washington, D. C., April 24, 25 and 26, 1939.

[2] Given at the annual dinner for the presentation of medals, April 25.

The academy itself is a small body compared with the great body of professional scientific men in the universities and colleges, in the schools of technology and medicine, in the engineering profession and in medicine, in the research institutes, in government service and in the industrial research laboratories of the country. The academy took a great step forward in the way of wider representation when it organized the National Research Council in 1916 at the request of President Wilson. This body is defined legally as an agency of the academy, but it is much more than that in practice: it is a sister body, possessing a large measure of independence, with which the academy cooperates harmoniously and whole-heartedly in the carrying out of our public relations.

We are bound together most closely not only in administrative ways, but also in spirit and purpose. The overlapping membership is numerous, but the National Research Council has much greater latitude than the

academy in the selection of members, all of whom receive their formal appointments from the academy. Through the National Research Council we maintain close relations with the national scientific societies, the members of which in their several degrees represent the institutions and professions to which the great body of scientific men are attached. The influence of the academy reaches out into all the country.

The Government of the United States recognized the significance of science to society long before our industrialists. You will find this foreshadowed in the words and acts of Washington and Jefferson, and in the early establishment of research in the scientific bureaus of the government. The incorporation of this academy in 1863 was, indeed, not possible until much progress had been made in this direction. But in the early years of my apprenticeship in the last decade of the nineteenth century, science and industry were hardly yet on speaking terms. Certain significant exceptions might be cited, but I am speaking broadly.

From the state of being largely ignored as a social and economic factor, science has in my own lifetime reached the condition of credit for complete transformation of the social and economic conditions of modern life, and this arouses expectations of new discoveries that will quicken old and create new industries, that will protect us in time of war, that will improve the health of the people and its innate qualities, and that will enable governments better to discharge their almost infinitely complex responsibilities.

It is unthinkable that the National Academy of Sciences should not respond to the utmost of its capacities. Created as it was to advise the agencies of the Federal Government on any subject of "science or art," and pledged as each member is to render his services to the government without any compensation whatever, the present grave time calls for a renewed dedication to the service of our country. Our government expects and is entitled to this service from us by the very articles of incorporation.

The intention of the creators of the academy was not, however, to establish another bureau under government control—either in the minds of the government or of the founders themselves—it was, on the contrary, to establish a free and independent body, with complete control over election to membership, that could be relied upon to advise without bias or fear. For this reason the no-compensation clause, to which I have alluded, was introduced; and for this reason the academy itself has neither sought nor received financial support from the government.

Four years ago my predecessor in office, the deeply lamented William Wallace Campbell, reminded us of the similarly disinterested position of the Royal Society of London, and quoted the statement in the annual address of the president of the Royal Society in 1904, Sir William Huggins:

> . . . The Royal Society . . . asks for no endowment from the state, for it could not tolerate the control from without which follows the acceptance of public money, nor permit of that interference with its internal affairs which, as is seen in some foreign academies, is associated with state endowment.

The functions of the National Academy in relation to the government were much more fully defined in President Wilson's executive order of May 11, 1918, in which he requested the National Academy of Sciences to perpetuate the National Research Council. Every member of the academy should occasionally read this executive order, prepared with the advice of some of our members, for it is the principal outstanding historical event, so far as the academy is concerned, since its foundation. The most important extension of the charter is undoubtedly the direction to the National Research Council "to develop effective means of utilizing the scientific and technical resources of the country" for stimulation of scientific research and its applications in engineering, agriculture, medicine and industry, for strengthening of the national defense and for cooperation in the interests of the public welfare in general.

I speak of these things as functions of the academy because of my strong conviction that the academy and the council are one and indivisible. Perhaps this conviction was quickened by my unique experience of holding simultaneously, for the space of one year, both the offices of president of the academy and chairman of the National Research Council; but in the three years ensuing this conviction gained strength.

Now these responsibilities are rather overwhelming, and it is no wonder if at times, since the enthusiasm of the Great War, our footsteps may have seemed to falter. The discharge of them requires the closest cooperation between academy and council. We must be constantly watching the tide and be prepared to take it at its flood.

There is not time to enumerate many accomplishments or specific activities. These are described, if not vivified, in the grave and gray pages of reports; and the prepared, intelligent and sympathetic mind can learn much from them. Would that some of our critics had so profited!

A considerable number of important special projects and studies of the National Research Council are quite adequately supported by special funds generously provided by foundations and others. But support of the general strategy and overhead expense involved in the promotion of the scientific, industrial and social, governmental and public interests, both of the academy and the council, is woefully inadequate and quite incommensurate with the opportunities and responsibili-

ties. The possibilities for service can not be fully realized until the free income of the academy and council is greatly increased.

I shall not dwell upon the activities of the National Research Council, in the attempts to raise the standards of the scientific personnel of the country through post-doctrate fellowships and in numerous other ways; nor on the rapidly developing relations with industrial and medical research; nor yet on the several continuing projects of stimulation of research or of aids to learning in special fields supported by various foundations; nor even on the several research organizations fostered and in some cases set up by aid of the National Research Council. I shall leave these reviews and others to the chairman of the National Research Council at the appropriate time.

But I would like to say something about the government relations of the academy and council. Here I wish to draw a distinction. On the one hand there are day-by-day relations, formal and informal, which are sustained by the chairman of the council, by the executive secretaries of the academy and the council, and as opportunity offers, by members of both, either in official or unofficial capacities. On the other hand, there are formal reports prepared at the request of government agencies by committees appointed by the president of the academy. Somewhere in between comes our relationship with the National Resources Committee of the government through its science committee, on which we have three representatives.

I do not exaggerate when I say that our success in carrying out the obligations of the charter of the academy depends upon what I have called day-by-day relations with government agencies. For it is necessary that we should know them, and that they should know us. In no other way can our relations succeed. They should know that we are here as friendly fellow-citizens with some scientific information, and that if there is occasional criticism on our part it is that of friends with a double stake in the problems with which they deal. They should also know that we are in a position to aid them in utilizing the scientific resources of the country. In this process of growth of mutual understanding we rely especially on those members of the academy and of the council who are also in the direct service of the government.

The rendering of formal reports is occasional. Into these reports should always go the best opinion of the academy. They should be judicial and authoritative. It is such reports that the Congress and the founders of the academy had in mind when framing the act of incorporation. The academy must therefore decline to attempt reports in fields in which it is not fully competent.

In the organization of the academy and council, the Government Relations and Science Advisory Committee, of which the president of the academy is chairman *ex officio*, has special oversight of such reports, which are prepared by subcommittees appointed by the chairman. Such subcommittees are appointed on formal request by the appropriate officers of the government, and the agency concerned provides by contract for payment of out-of-pocket expenses of members of the subcommittees and for any necessary expenses of investigation; but the members of the subcommittees receive no compensation whatever for their services.

At the present time six such subcommittees are in operation, two of these being retained as advisory committees to the agencies in question. Three other advisory committees, not concerned in the preparation of formal reports, have also been appointed as subcommittees of the Government Relations and Science Advisory Committee. It is perhaps needless to say that the proceedings of such committees are held confidential, by the academy, but may be released by the government.

The National Resources Committee, engaged in the preparation of plans for the long-time utilization of national resources, reports its findings to the President and the Congress with recommendations. Such planning involves land, water, public works, industry, energy sources and population. In each of these divisions scientific considerations are of primary importance. A little more than four years ago, the chairman of this committee, the Honorable Harold L. Ickes, requested the president of the academy to appoint three of its members to a science committee of the National Resources Committee, which includes also three members representing the social sciences and three representing education. This was accordingly done, and the academy has been so represented ever since. The work of this committee has been of growing importance, and our own relations to the government have profited increasingly through it. The academy and the council highly value this new avenue of relations with government agencies.

FRANK R. LILLIE

## ABSTRACTS OF PAPERS

*Ultra-violet solar intensities and ozone distribution in the upper atmosphere:* W. W. COBLENTZ and R. STAIR. In a preliminary report (SCIENCE, 87: 426, 1938) a summary was given of the progress made in measuring the ultra-violet solar intensity and thereby determining the vertical distribution of atmospheric ozone at various heights above the earth's surface, by means of a photoelectric ultra-violet intensity meter and auxiliary radio-transmitting apparatus, transported aloft by means of unmanned balloons. As a matter of record the following report is given of the results obtained, during the summer of 1938, with the aid of a grant from the Joseph Henry Fund, in cooperation with the National Bureau of Standards. Two kinds

of measurements were obtained: (a) the spectral quality and total intensity of ultra-violet solar radiation, at a fixed ground station, at Flagstaff, Arizona (elevation 2.2 km), and (b) similar measurements at various elevations above the earth's surface, at Washington, D. C. In the ultra-violet measurements at Flagstaff, a close parallelism was observed in the variation in the percentage transmission of the filters with variation in barometric pressure; in agreement with the well-known variation in the amount of atmospheric ozone that accompanies a change in air pressure. On one occasion the wave of low barometric pressure preceded, by 5 to 6 hours, an appreciable increase in atmospheric ozone; indicating a method of studying the circulation of ozone in the stratosphere. In four balloon ascensions, made in Washington, D. C., in June, 1938, the photoelectric ultra-violet intensity meter attained heights ranging from 25 to 27 km; penetrating 60 to 70 per cent. of the atmospheric ozone, the most of which was localized in a layer extending from an elevation of 18 to 27 km, with a wide maximum of concentration at a height of about 25 km above sea level. At the highest elevation attained by the instruments the intensity of the ultra-violet of short-wave lengths was about ten times that of direct sunlight at sea level.

*A new method of determining individual line-of-sight velocities of star groups:* R. W. WOOD. Two prisms of 6° angle are mounted one above the other with refracting edges pointed in opposite directions. Each is covered with a replica grating of 4,800 lines to the inch, giving 85 per cent. of the light in the first order spectrum, the combination giving direct vision for the violet region. One grating is inverted with respect to the other, the combination giving two parallel spectra of each star, in coincidence in the violet and ultra-violet regions, the red ends lying in opposite directions. Line of sight velocity causes the spectra to shift in the direction of their length and in opposite directions. Excellent spectra have been obtained of bright stars with a lens of 3 inches aperture and 16 inches focus at the observatory of Mr. Joseph Woods, of Baltimore.

*Cosmic ray intensity and the thermal expansion of the atmosphere:* A. H. COMPTON, M. SCHEIN and P. S. GILL. The temperature coefficient of the intensity of cosmic rays found by one of us in the data obtained in the northern and southern hemispheres of the Pacific Ocean has recently found a suggested explanation by Blackett. This is based upon Yukawa's hypothesis that the mesotrons which constitute these cosmic rays are produced in the upper atmosphere by less penetrating radiation and that they show spontaneous disintegration similar to radioactivity. When the atmosphere expands at the higher temperature, the elevation at which the mesotron is produced is greater and there is a higher probability of spontaneous disintegration resulting in a lower intensity at sea level. Using for the mean life of the mesotron when at rest $\tau_0 = 2.7 \times 10^{-6}$ sec., Blackett thus calculated a temperature coefficient agreeing closely with that observed by us. He predicted, likewise, that near the equator, where the average energy of the mesotron is greater, the temperature coefficient should be smaller. Using extensive additional data from the Pacific Ocean, we have experimentally confirmed Blackett's predictions of a smaller temperature coefficient in equatorial regions. We have calculated from our data the altitude at which the mesotrons are created in the earth's atmosphere and find that this is a maximum of about 25 kilometers at a latitude of about 38°. This corresponds to the knee in the latitude effect curve. The variation in the altitude at which the mesotrons are produced gives a significant indication regarding their method of production.

*Seasonal effects in cosmic ray intensities from sea level up to the top of the atmosphere:* ROBERT A. MILLIKAN and H. VICTOR NEHER. By sending our self-recording electroscopes on successive trips from Los Angeles to Vancouver and back, and then around South America and back to Los Angeles, we have checked in these areas the result first recorded by Steinke and very carefully studied later by Messerschmidt, Hess, and Compton and Turner that there is a definite seasonal sea-level variation in cosmic-ray intensities. Like the last observers, we find no seasonal effect in the equatorial belt, but in the higher temperate zones the sea-level intensities are definitely higher by from two to four per cent. in winter than in summer. Furthermore, recent flights which we have made at Omaha up to close to the top of the atmosphere reveal similar but considerably larger intensity differences between winter and summer, the winter readings being consistently higher. These Omaha results seem to be scarcely explicable in terms of the theory advanced by Blackett.

*Further confirmation of the Coster-Kronig theory of the production of doubly-ionized atoms:* F. K. RICHTMYER and ROSS E. SHRADER. At the Rochester (1937) meeting of the academy we reported measurements on the satellites of the x-ray line $L\alpha$ in the atomic number range $73 < Z < 92$, which qualitatively confirmed the theory proposed by Coster and Kronig (*Physica*, 2: 13, 1935) that the initial state for the production of these lines is a doubly ionized state, $L_{III} + M_{IV, V}$, arising from an internal absorption of energy known as the Auger effect. The energy required to expel an $M_{IV}$ electron from an atom is sufficiently higher than that required to expel an $M_V$ electron so that, while satellites due to $(L_{III} + M_V)$ ionization should appear above Ta 73, satellites due to $(L_{III} + M_{IV})$ ionization should not appear until Ir 77 is reached. We now report more accurate data for the intensities of $L\alpha$ satellites in the range $73 < Z < 92$ obtained by a high-resolving-power two-crystal spectrometer. The curve of intensity vs. Z shows two branches, one beginning at Ta 73 and the other at Ir 77, in excellent agreement with the Coster-Kronig theory.

*The number of lines in a series as a function of electron pressure:* FRED L. MOHLER (introduced by W. W. Coblentz). In an intense discharge the higher series lines merge into a continuous spectrum at an effective quantum number which depends on the electron pressure. Studies of the cesium discharge covering a wide range of vapor pressure and current density give a basis for determining this relation. The maximum quantum number in a series is found by plotting the relative intensity of line to background versus quantum number

and extrapolating to a ratio of unity. The relation between electron pressure and the maximum quantum number for both the red component of the D series and the F series is $P_e$ (atmospheres) $= 4.5Tn^{-7}$. Computations by Pannekoek for the Balmer series indicate that this relation is equally applicable to hydrogen. The number of absorption lines in the Balmer and Paschen series of some stars has been determined by the same criterion used for cesium. For main sequence Ao stars the electron pressure at the photosphere is about $0.4 \times 10^{-4}$ Atm. at the Balmer limit, $0.8 \times 10^{-4}$ at the Paschen limit and $2 \times 10^{-4}$ Atm. at 4340A. Alpha Cygni has an electron pressure of about $2 \times 10^{-6}$ Atm. at the Balmer limit, while for white dwarfs the pressure is roughly $10^{-2}$ Atm.

*The Hall effect and change of resistance in a magnetic field:* W. V. HOUSTON and L. DAVIS (introduced by R. A. Millikan). The normal Hall effect can be directly interpreted in terms of almost free electrons, although the positive Hall effect requires for its explanation electrons whose binding to the nuclear lattice is of considerable importance. On the other hand, the change of resistance in a magnetic field can be interpreted only on the assumption that the nuclear binding causes essential departures from the behavior of free electrons. These facts can be easily illustrated in a qualitative way. Since a change of resistance is observed in the alkalis, it is of interest to see if this can be understood quantitatively as a small departure from a free electron situation. The electron energy as a function of wave number, as well as the relaxation time, can be expanded in a series of spherical harmonics that have the symmetry of a cubic crystal. This permits the necessary integrals to be carried out to any desired degree of approximation. When only the first two harmonics are retained, the computed change of resistance and Hall effect are close to the observed values. However, the ratio of the transverse to the longitudinal change of resistance can not have a value less than four. This is not in agreement with the available observations. It seems improbable that this result could be changed in any major way by the inclusion of higher series members, so that if the experimental results are to be taken as reliable, doubt is thrown upon the basic method of interpretation of the effects.

*The cause of intense color in the carotenoid pigments:* ROBERT S. MULLIKEN. As is well known, the carotenoid pigments, which are responsible for the color of various vegetable and animal substances (*e.g.*, carrots) have a conjugated polyene structure. That is, each molecule contains a long chain of alternately single and double carbon-carbon bonds. A theoretical explanation of the existence of visible absorption, hence of color, for such molecules is implicit in quantum-mechanical calculations of Hückel, although Hückel did not himself discuss the spectra. In the present work, quantum-mechanical calculations of the intensities of various spectral absorption regions are made, and it is shown thereby theoretically that the longest wave-length absorption region should be by far the strongest, with very high intensity indeed. This is in agreement with experimental observations. Thus the exceedingly strong visible absorption of the carotenoids, giving intense color, is explained. According to the theory, the shape of the molecule should strongly affect the distribution of intensity in its spectrum. The more elongated the molecule, the more the intensity should be confined to the long wave-length end of the spectrum, and the more intense should be the color. Available experimental evidence on substituted polyenes supports the theoretical predictions if it is supposed that polyene chains normally assume the most elongated possible form. When part of the polyene chain is bent into a ring, the intensity is reduced. According to the present calculations, the intense long wave-length absorption regions in elongated carotenoid molecules correspond to light polarized approximately along the long axis of the molecule. This should give rise to a high polarizability of such molecules along that direction, and this may help to explain their reactivity.

*The "liquid structure" of water; with special reference to ionic solutions:* G. W. STEWART. The recognition of the manner in which water as a solvent may alter its density is recent. Experimental evidence from an x-ray study of the aqueous solution of fifteen electrolytes is now adduced to show that the ions in solution have a more significant effect than is explicable on an electrostatic basis. This is the alteration in liquid structure of the water through the increase in coordination number. This change in number occurs similarly with increase in temperature of pure water. The variation with concentration of the structure, as indicated by x-rays, has a striking correspondence with the variation of the apparent molal ionic volume. The ions were both simple and complex with six of the electrolytes of a 1–1 type, six of them 2–1, two of 3–1 and one of a 1–2. The effect of the increase in coordination number of the water is to give closer packing and greater density.

*The automatic synthesis of speech:* HOMER DUDLEY (introduced by O. E. Buckley). Synthetic speech has been formed with an electrical circuit by the modulation of a buzzer-like tone for the voiced sounds and a hiss for the unvoiced sounds. The tone consists of a fundamental vibration and its harmonics; the hiss, of purely random vibrations. The modulation processes are of two types: one, a pitch variation for inflection in the synthetic voiced sounds and the other, amplitude variations of the component vibrations in both the voiced and unvoiced sounds. In the automatic synthesis of speech the two basic sounds are modulated by speech-defining electrical currents, varying at syllabic rates, which are obtained by a substantially instantaneous analysis of a talker's speech. The artificial speech is not only intelligible but reproduces in good measure the inflection and timbre of the original. The simplicity of these speech-defining currents points to such future possibilities as aural speech studies by their controlled modification and reduction in frequency band required for telephonic transmission. The procedure and results will be illustrated from phonograph records.

*Breakdown in impregnated paper insulation:* J. B. WHITEHEAD. In accordance with current theories of the nature of breakdown in solids, it has been assumed that an increase in the density of the impregnated paper used

for cable insulation results in a higher dielectric strength. Following this assumption, manufacturers have used high density papers for a redistribution of normal stresses within the insulation and also for the purpose of increasing dielectric strength. In the present tests four grades of paper of different values of density, but all from the same wood pulp stock and all the same thickness, have been studied in accelerated life tests. In these the voltage was raised with a gradual logarithmic increase, with measurements of various electrical quantities at intervals up to final breakdown. The average duration of the test was about four days. The results show that with increasing specific gravity of the paper, the dielectric strength of the impregnated sample, instead of increasing with increasing density, shows, in fact, a noticeable decrease. Within the range of specific gravity of the paper 0.74 to 1.18, the decrease in breakdown voltage is 30.5 per cent. and the decrease in life is 47 per cent. An explanation of the above result has been found in the use of a device for limiting the current and consequent burning of the breakdown process, and for locating the point at which breakdown begins. The device consists of a thyratron tube controlled by the current from the specimen, and which in turn operates a rapid circuit breaker. Careful examination and dissection of the specimens reveals that breakdown almost invariably begins in the narrow channels between two successive spirals of the paper tapes, these channels being filled with oil. Corresponding measurements of dielectric constant of the oil, of the paper and of the impregnated paper permit computation of the stresses in these oil channels. It was found that these stresses had approximately the same value for all four grades of paper. Thus the decreasing dielectric strength with increasing paper density is caused by the increased dielectric constant of the impregnated paper, as this increase shifts a greater proportion of the total stress to the oil in the oil channels. The values of the stress in the oil channels immediately preceding failure were in the range 1,300 to 1,500 volts per mil. Apparently in this neighborhood ionic motion in the oil becomes so rapid as to cause secondary ionization, increased conductivity, gas liberation and ultimate gaseous ionization, with resulting chemical or thermal attack of the paper structure causing rapid penetration of the latter and leading to complete breakdown.

*The neurohumoral activation of vertebrate chromatophores:* G. H. PARKER. Two decades ago all vertebrate color-cells would have been said to be under the control of the nervous system. Since that time intermedin, the neurohumor of the intermediate lobe of the pituitary complex, has been shown to be the chief agent in causing darkening in these animals. Only a few teleost fishes appear to be exceptions to this rule, which holds in general for most fishes, and all amphibians and reptiles thus far tested. Darkening is also accomplished in certain teleosts by dispersing nerves. The blanching of chromatic vertebrates is due chiefly either to a loss of intermedin, to the action of such a concentrating neurohumor as adrenalin or to concentrating nerves. From the modern standpoint the blood-soluble hormones intermedin, adrenalin and other like substances far outrun nerves in their control of chromatophores. They appear to be the exclusive agents in the cyclostomes, most elasmobranchs, all amphibians and such lizards as Anolis. Obvious nerve control appears only in a very few elasmobranchs, a number of teleosts and such lizards as the chameleon and the horned toad. Where nervous control has been studied, chiefly among fishes, it is believed both in its concentrating and its dispersing phases to depend upon oil-soluble neurohumors, the lipohumors, from the nerve terminals. Thus the activation of vertebrate chromatophores appears to result in the main from blood-soluble hydrohumors, chiefly intermedin and adrenalin, supplemented by several lipohumors from direct nervous sources. It is remarkable that in these responses acetylcholin appears to play little or no part.

*Changes of viscosity and cell activity:* WARREN H. LEWIS. Changes of viscosity of protoplasm, sol to gel, gel to sol and intermediate states, play important roles in cell activity. Gelated colloids *in vitro* automatically exert contractile tension and presumably gelated protoplasm acts likewise. The assumption that active cells possess a superficial layer of gelated cytoplasm, the plasmagel layer, which exerts contractile tension offers a key for an explanation of various cell activities. A uniform tension would tend to make cells spherical, local variations of it would produce distortions and thrust out cell processes and pseudopodia. It plays the leading role in locomotion of cells. An early indication that a cell is about to divide is the retraction or partial retraction of its processes and pseudopodia. This is probably due to an increase in the viscosity of the superficial plasmagel layer of the processes which automatically increases their contractile tension. The cell then tends to become spherical, due to the development of a more uniform viscosity of the superficial plasmagel layer over the body of the cell. The cleavage of cells in mitosis is to be explained by the development during anaphase of a thickened or denser equatorial band of the plasmagel layer which automatically flattens and then constricts the cell because of the increased contractile tension developed. Deeper within the cell changes of viscosity play equally important roles. When the chromosomes are in the equatorial metaphase plate motion pictures reveal that individual chromosomes oscillate independently of one another in paths between the poles of the spindle. This suggests (1) that in the living cell there are, after all, invisible spindle fibers which extend from each chromosome to the poles of the spindle; (2) that the fibers are gels and hence exert contractile tension on the chromosomes; (3) that the two fibers of each chromosome undergo somewhat irregular alternate changes in viscosity with corresponding changes in contractile tension; and (4) that the oscillation of each chromosome is thus due to this alternation of pull on it, first toward one and then toward the other pole of the spindle. When the chromosomes are pulled or split apart oscillation ceases and each half moves or is pulled steadily toward its respective pole by the contraction of its spindle fiber.

*The time factor in x-ray irradiation:* KARL SAX (introduced by I. W. Bailey and E. D. Merrill). Most of the

experiments on the effect of x-ray intensity show that concentrated doses are more effective in killing cells than the same dose given slowly. Similar results have been obtained for chromosome aberrations in Tradescantia. Both intermittent raying and continuous raying at various intensities show the effect of the time factor. In one experiment with a total dosage of 320 r, given at various intensities from 20 to 320 r/m, the relation between the percentage of chromosome breaks and radiation intensity is expressed by the equation, $\log B = 0.314 \log I + 0.764$. Previous experiments on the nature of x-ray-induced chromosome aberrations provide an explanation of the effect of the time factor. Most of the aberrations induced in the resting nucleus are dependent upon two independent x-ray hits. If the radiation is given slowly a break in one chromosome may heal before another break occurs in an adjacent chromosome. The second break also heals and no visible aberrations appear at metaphase. When the radiation is intense two adjacent breaks may occur within the critical time period, so that fusions can take place between broken ends of different chromosomes and produce dicentric chromosomes. In cells irradiated at prophase both 1-hit and 2-hit breaks occur with a rather high frequency, but only the 2-hit breaks are affected by the time factor. Broken ends of chromosomes may remain in an unstable condition and retain their capacity of fusion for about one hour. The duration of the nuclear cycle in the Tradescantia microspores is about one week. This interpretation of the time factor in irradiation may have some application to x-ray treatment of cancer. Intermittent radiation of low intensity should produce sufficient breaks in prophase nuclei to prevent normal cell division, but with little injury to the less active cells of normal tissue.

*A new dominant lethal, E, in Neurospora tetrasperma:* B. O. DODGE. Ascospores from a culture of *N. tetrasperma*, race substriata from Texas, which had been kept dry for five years germinated fairly well following heat treatment. Their mycelia gave rise to normal ascocarps with 4-spored asci except in one case, where a large percentage of the asci aborted without spore formation, but with no induration of the ascus wall. In some ascocarps no asci with spores were present. As a rule when asci did mature spores there were usually eight and not four spores as should have been expected. All ascospores from an 8-spored ascus that germinated and developed mycelia were normal, since ascocarps formed when two of opposite sex were mated gave 4-spored asci, never 8-spored asci. Occasionally, an ascus delimits seven spores, one being larger and bisexual and one of its nuclei being normal, while the other nucleus, which is usually of opposite sex, carries a new dominant lethal factor, E. A mycelium from such a spore bears ascocarps, the asci of which, with few exceptions, all abort. Such a lethal factor must be dominant because every ascus, of which there are over a hundred in each fruiting body, is heterozygous for the lethal. This new dominant lethal, E, differs from the lethal, I, previously described, in that no induration follows ascus abortion, and asci that do develop spores are usually 8-spored and not 4-spored. In both cases these lethal factors can only be carried along in a cell having another nucleus which is normal or non-lethal.

*The nature of x-ray-induced lethal changes in the Notch region of the X-chromosome of Drosophila melanogaster:* M. DEMEREC (introduced by A. F. Blakeslee). Cytogenetic study is completed for 36 lethal changes induced by x-rays in the white-Notch region of the X-chromosome. Numerous types of the same region showing mottling, as well as numerous viable changes will not be considered here. X-rays of about 0.72A° and dosage of 2,500 to 3,000 r-units were used in these experiments. Of 36 changes, 7 are connected with either inversions or translocations, 26 are deficiencies showing in salivary gland chromosomes a section of from 1 to 46 bands missing, while three cases had no such cytologically detectable deficiency. A deficiency may be induced either by the occurrence of two breaks, the piece between the breaks being lost or by the elimination of a piece through a chemical change. A study of 1,038 induced breaks made by Bauer, Demerec and Kaufmann shows that they are distributed at random and that they occur independently. Thus, if two independent breaks are responsible for a deficiency, it is to be expected that deficiencies of various lengths will occur with an approximately equal frequency. That holds true for deficiencies involving 5 to 46 bands, but small, 1–4 band deficiencies are much more frequent than expected (12 from 27 cases). This indicates that large deficiencies and part of the small ones are probably induced by two independent events, while the majority of small deficiencies are induced by one event, either an extensive chemical change or two interdependent breaks. The majority of changes involving inversions or translocations showed no cytologically detectable deficiency (6 from 7), indicating the effect of the position on the action of a gene. Salivary chromosome bands, as shown on Bridges' 1938 map, were correlated with genetic loci through overlapping deficiencies as follows: white 3C1, roughest 3C4, facet 3C7 and diminutive 3D1.2 doublet.

*Rhythmical impulses in the heart and in a plant cell (Nitella):* W. J. V. OSTERHOUT and S. E. HILL. In the heart rhythmical electrical impulses originate in a pacemaker and pass from the auricle to the ventricle. Under certain conditions the rhythm in the auricle becomes too rapid for the ventricle to follow, so that only every second or third impulse passes over. This is known as partial block: complete block also occurs and the ventricle then takes up a rhythm of its own. Various irregular rhythms are encountered, including electrical alternans (every other impulse stronger) and premature beats followed by an extra long pause (as in extra systole). Experiments have been made by creating a pacemaker at one end of a *Nitella* cell by applying a drop of potassium chloride. When the electrical rhythm is made rapid by previously treating the cell with sodium chloride we observe many of the irregularities found in the heart. The irregularities found in the heart have sometimes been regarded as arising in the bundle of His by which the impulses pass from the auricle to the ventricle. Such an explanation can not apply to *Nitella*, in which the conducting medium is undifferen-

tiated protoplasm. Apparently, all conducting systems have certain fundamental factors in common, which make such irregularities possible.

*Induction of periclinal chimeras in Datura stramonium by colchicine treatment:* A. F. BLAKESLEE, A. D. BERGNER, S. SATINA and E. W. SINNOTT. It has been earlier reported that colchicine by its action on dividing nuclei may induce a doubling of the number of chromosomes in the individual cells affected. When $2n$ seeds of *Datura stramonium* are treated, a mixture of $2n$ and $4n$ tissue results from which pure $2n$ and $4n$ branches as well as branches which lack one or more chromosomes may arise. It is now possible to report from seed treatment of Daturas the occurrence of periclinal chimeras in which the cells of the inner portions of the branch have the normal number of chromosomes, while the cells of the outer tissue contain the doubled number. The occurrence of these periclinal chimeras has been established by several lines of evidence. In many cases the appearance of a given branch disagreed with the chromosome number of the generative layer estimated by size of pollen grains or determined by actual chromosome counts in pollen-mother cells. Guard cells of the epidermis and their nuclei in some cases were of the $4n$ size, while the pollen mother cells were $2n$. Cross sections of flower stalks in such cases showed the epidermis cells enlarged like those in $4n$ plants but the inner cells of the size characteristic of such $2n$ tissue. The size relations of cells have been checked by chromosome counts. In periclinal chimeras in which the epidermis is $4n$ and the inner tissue $2n$, it is possible to identify cells of epidermal origin by their chromosome number. It is thus possible to show that part of the internal tissue of calyx, corolla, stamens and pistil are derived from the epidermal layer and that the chromosomal constitution of the epidermis is of major importance in determining the shape of the mature capsule.

*The chemical induction of genetic changes in fungi:* CHARLES THOM and ROBERT A. STEINBERG. The monographer of molds finds groups of strains differing in colony aspect to a degree commonly accepted as specific but producing spores with essential characters in common. Discrimination between variation, mutation and specific identity is difficult. The possibility of increasing the numbers of variants among fungi upon definite lines, by stimulating substances seemed worth considering. The molds selected were strains of *Aspergillus niger, A. amstelodami* and *Penicillium caseicolum* which had grown in the laboratory more than 20 years without noteworthy variation. Neither colchicine nor acenaphthene produced inheritable variations. A large number (154) of dyes, phenanthrene derivatives and miscellaneous organic compounds led only to sporadic variants with the *Aspergilli,* none with *Penicillium.* Growth in a nutrient salts solution containing carbon as 5 per cent. mannitol, nitrogen as 0.2 per cent. sodium nitrite and adjusted to pH 4.0, gave almost invariable response with the *Aspergilli.* Changes in dilutions were occasionally required. *Aspergillus niger* has formed thus far about a dozen variants which persist in culture and tend to reappear in successive trials. *Aspergillus amstelodami* produced a variant differing greatly in colony character, with ascospore production greatly delayed and almost suppressed. The variants show suppression of characters, production of sterile mycelia, reduction of accessory spore-producing mechanisms such as stalk, and vesicle of Aspergillus to vestigial, and spore production reduced to small clusters of spore-producing cells with short chains of conidia. Spores when produced retain the sizes and markings characteristic of the species. Similar variants are already known among the black Aspergilli. A similar series in *A. sydowi* have been collected in nature. Hypothetically the process involved may be due to the effects of nitrous acid on amino nitrogen, suggesting the possibility that other natural aberrant forms may also be associated in some instances with excess nitrite.

*Cellular relationships during growth and differentiation in plant growing-points:* EDMUND W. SINNOTT. By means of a technique previously described it is possible to study the multiplication, enlargement and differentiation of living cells in the apical meristems of certain roots. Changes in a given cell are found to be closely related to those in the cells which surround it. In rapidly growing roots, when a cell divides, the new transverse wall tends to be laid down in a position as far as possible from contact with the transverse walls of neighboring cells. In most slowly growing roots, where the longitudinal walls have become firmer, this relationship is less pronounced. A study of expanding cells indicates that the cells do not slide along one another, but that the wall of one cell is firmly attached to those of its neighbors. Different portions of a cell wall, however, may expand at different rates during the process of development, so that the relative sizes of cells become altered; but the growth of any portion of a cell wall is the same as that of the adjacent wall of its neighboring cell. This process of differential wall growth is an important aspect of cellular differentiation.

*The active uptake of ions by organisms:* AUGUST KROGH. It is well known that the ionic composition of the protoplasm in animal cells differs significantly from that of the surrounding fluid, and in the case of a few eggs there is evidence to show that ions are absorbed from very dilute solutions. In the large plant cells, studied by Osterhout, Collander and others, active absorption of ions into the cell sap has been observed and mechanisms for such absorption suggested. In plant roots Lundegårdh has demonstrated an active transport of anions from very dilute external solutions into the much more concentrated sap rising in the stem. In a number of fresh-water animals we have observed more or less specialized mechanisms which take up certain ions from the outside solution and concentrate them say from millimolar or less to 100 millimoles in the blood. We find separate mechanisms for kations and anions, respectively. In certain Crustacea the kation mechanism will take up Na and K indiscriminately, leaving out Ca, but in most animals studied the mechanism is strictly specific for Na only. The anion mechanism has been found in a single case not to discriminate between Cl, Br, CNS and CNO, but in all other cases it is specific for Cl and Br, which can not be distinguished, either, by

the kidney mechanism of man. It is suggested that all these mechanisms are nearly related, but that the more specialized are more likely to furnish clues as to the modus operandi.

*The ontogeny, nature and mode of activation of the intracellular enzyme, tyrosinase:* JOSEPH HALL BODINE (introduced by Carl E. Seashore). By means of manometric methods the growth of the enzyme tyrosinase has been followed throughout the entire development of the embryo of the grasshopper. Evidence has been obtained indicating the auto-catalytic nature of this growth. The enzyme as produced is in an inactive state and can be activated by a normally occurring intracellular activator as well as by various chemical and physical reagents such as sodium oleate, acetone, ether, chloroform, heat, etc. The kinetics of the activator have been studied in some detail. The parts played by the denaturation and active center formation in protein are discussed; a probable correlation between these and the activation of the enzyme is pointed out.

*Evidence for the existence of an electro-dynamic field in living organisms:* H. S. BURR (introduced by Walter R. Miles). The existence of electrical activity in living things is attested by electrocardiographs and electroencephalographs. Recently, it has been possible to add to these graphs of steady state voltage differences which possess definitive patterns characteristic of the species to which the animal belongs and, in all probability, of the individual itself. This pattern has been shown to change with alterations in the fundamental activity of the organism. In the growing embryo the electrical pattern develops hand in hand with the development of the whole organism. A definite cycle of electrical phenomena correlates with the menstrual cycle in women. Under proper conditions it has been possible to record electrically the exact instant of ovulation in rabbits, cats and women. The progress of healing in wounds shows electrical concomitants which parallel very closely the reparative process. In mice it has been possible to detect adenocarcinoma of the mammary gland by characteristic changes in the overall electrical pattern of the organism a week or more before it can be detected by palpation. The results of many hundreds of thousands of determinations indicate that relatively steady state voltage differences are an expression in quantitative terms of one form of the relationships which exist between the units of the organism. This suggests that the simplest assumption with which to explain all the evidence so far gathered is that of the existence in the living organism of an electro-dynamic field.

*The steady potential of the human eye in subjects with unilateral enucleation:* WALTER R. MILES. The electrical potential derived from the human eyeball may be measured with a sensitive galvanometer connected with small metal foil electrodes on the skin near the eye. Measurements may be made with subjects reclining in a chair or sitting upright at a headrest. The method of making such examinations, and their reliability, has recently been described. The present study deals with an analysis of data secured on a group of subjects who have suffered unilateral enucleation, and in consequence have to wear one artificial eye. The steady potentials found in 9 such cases are compared with the steady potentials found for normal subjects who each have two living eyes. The relationships previously described, Ld. 1 plus Ld. 2 = Ld. 3 plus Ld. 4 can not hold in cases of unilateral enucleation. In the normal eye it is found that the potential is larger after abductive movements than after adductive movements. The difference is usually about 8 per cent. The same relationship is found to hold for the enucleation group. The bitemporal lead in the normal group gives a potential value that is one third larger than the mean of the two eyes measured separately. In the enucleation group this is essentially reversed, the single active eye providing a potential that is one third larger than that found for the bitemporal lead. The enucleation group provides a special opportunity to analyze the potential-field relationships associated with and surrounding a single active eye. Lantern slides will be used.

*The span of visual discrimination as a function of duration and intensity of stimulation:* W. S. HUNTER. A study of the span of visual discrimination as dependent upon the duration and intensity of stimulation affords an opportunity to relate what has been known as the span of "attention" to known facts of light stimulation. The Bunsen-Roscoe Law, $I \cdot t$ equals a Constant, has been shown to hold within limits for a variety of biological processes ranging from the heliotropic curvatures of seedlings to visual acuity in man. In the present experiments, which are the first systematic study of the effects of time and intensity on the span of discrimination, the law has again been found to hold within certain limits. In the present work light of controlled intensity and duration was transmitted through stimulus plates containing various numbers of black dots on translucent white paper, the entire stimulus falling within the fovea of the subject. The absolute intensities ranged from 0.016–13.3 millilamberts; the durations of stimulation, from 0.004–1.0 sec. The subject's response indicated the number of dots seen at each presentation. For each time and intensity, limens were determined showing the number of dots seen correctly 50 per cent. of the time. When these limens are plotted against log I, there results a family of curves for the different durations showing decreases in the required intensities with increases in time. The maximal limen for durations of 0.004, 0.008, 0.016, 0.032 and 0.075 secs. was 8 dots, although the intensities at which the limen was reached varied with the different durations. For 0.150 secs., the maximal limen was 9 dots; for 0.30 secs., 10 dots; for 0.60 secs., 12 dots; and for 1.0 secs., 14 dots. A graph of log $I \cdot t$ against log T for the discrimination of 1, 2 or 3, and up to 6 dots indicates that $I \cdot t$ is constant for durations from 4 to 32 ms., after which the intensity required does not decrease proportionately as time increases.

*The function of the mute on the violin:* CARL E. SEASHORE, ARNOLD SMALL and E. P. HORNE. What is the effect of the mute on the total intensity and the harmonic

structure of the tone? This paper is a unit in a series of experimental studies on the acoustic characteristics of the violin. Tones were recorded from good violins, played mechanically in a dead room and submitted to harmonic analysis. The effect of shape, weight, material and seating of the mute was studied on each of the four open strings. It was found that the chief variable in a mute is its weight. The effect of size, material and seating were relatively insignificant; although different for the different strings. The mute tends to reduce the total intensity of the tone, not in the fundamental but in the other partials at various levels. The change of harmonic structure varies with the string, the pitch level, the character of the violin, the character of the mute and other factors. Results are shown in graphs.

*History in the archives of the Royal Society:* SIR WILLIAM BRAGG. The large store of papers in the possession of the Royal Society provides material for history from many different points of view. In particular, it shows how the simple experimental science of its founders, with their common interest in all that came under their notice, has gradually become the highly developed science of to-day, each section of which is intelligible only to its specialist. At the same time, the study of natural knowledge has become of great importance in all branches of human activity. The effects of these changes upon the relations between science and the human society are obvious and very important. They are in consequence receiving serious consideration. For this purpose it is of interest to compare the position of experimental science at different times since the Royal Society was founded: and the society's archives furnish convenient illustrations.

*Higher element transformations:* EDWARD KASNER. The concept of differential element is important in differential equations and physics. The simplest type in the plane is a point with a direction represented by $(x, y, y')$. The next type, here studied, is curvature element $(x, y, y', y'')$. A set of $\infty^1$ elements is called a *series*, $\infty^2$ elements a *field*, $\infty^3$ elements an *opulence*, and the totality of $\infty^4$ elements a *plenum*. The transformation problem of unions is known, the new problem relates to integrable fields (see *Proceedings* of the National Academy, February, 1939). The corresponding problem of surface elements in space $(x, y, z, p, q)$ relates to integrable fields and is more difficult (see *Duke Journal*, March, 1939). A new problem in space relates to sets of $\infty^1$ surface elements. When will surface strips go into strips? Finally, we study lineal elements in space $(x, y, z, y', z')$. If we consider merely $\infty^1$ elements, we obtain the classic theorem of Lie. However, when $\infty^2$ elements are considered, a new theory is obtained.

*(To be concluded)*

# OBITUARY

## HERBERT HENRY WOOLLARD

THE sudden death, on January 18, of Herbert Henry Woollard, professor of anatomy in University College, University of London, is a great blow to British anatomy and to his many friends throughout the world.

Woollard was born in Australia on August 4, 1889. He attended the University of Melbourne, graduating in medicine in 1910. With the coming of the Great War he joined the Australian Army Medical Corps, serving in both Gallipoli and Flanders and attaining the rank of lieutenant-colonel, with three decorations for gallantry. Following the war, he went to University College, London, to work for the fellowship of the Royal College of Surgeons. Here, largely through his contact with Professor Grafton Elliot Smith, Woollard's interests soon shifted to the field of anatomy and he became a member of the anatomy staff of University College, serving as assistant professor from 1923 to 1927. During this period he spent a year in the United States as a Rockefeller fellow, an experience that exerted a profound influence upon his later work. The friendships formed in America forged a strong link between British and American anatomy. In 1927, he was appointed to the chair of anatomy and histology at the University of Adelaide, returning to London in 1929 as professor of anatomy at St. Bartholomew's Hospital Medical School. Finally, in 1936, he succeeded Sir Grafton Elliot Smith in the chair of anatomy at University College, a post of utmost distinction. He was elected fellow of the Royal Society in 1938.

Woollard's interests covered an extremely broad scope. In his earlier years he chiefly devoted his attention to morphological problems, publishing, for example, a monograph on *Tarsius*—an outstanding contribution to primate anatomy—and a number of papers dealing with the visual pathways of primates. Much of his later work was of an experimental nature. It produced among others a series of publications on the innervation of the heart, blood-vessels and skin, which constitute his major contributions to anatomical science. At the time of his death he was concerned with other problems of cutaneous innervation and with the nervous system of coelenterates.

He was a man capable of inspiring deep devotion. Those who were privileged to work with him are particularly able to appreciate his sterling character—his uncompromising and outspoken honesty; his willingness to give unstintingly without thought of return, especially to younger workers; and his intense loyalty and devotion to his friends.

The death of Woollard at the early age of 49 years is an inestimable blow to British anatomy, for he was equally at home in microscopic and gross anatomy and, what is less common among morphologists, he knew how to utilize experimental methods for determining

the functional significance of the structures with which he was dealing. The success with which he already had applied these methods to some of the most important of anatomical problems gave much promise for the years ahead. His death therefore is all the greater loss.

WILLIAM L. STRAUS, JR.
THE JOHNS HOPKINS MEDICAL SCHOOL

## RECENT DEATHS

DR. EDWARD ANGUS BURT, formerly mycologist of the Missouri Botanical Garden, who has been living in retirement at his early home near Middle Grove, N. Y., since impairment of his eyesight, died on April 26 at the age of eighty years.

DR. ARTHUR P. JACOT, associate conservationist at the Northeastern Forest Experiment Station, U. S. Forest Service, New Haven, Conn., an authority on the fauna of forest soils, died on March 24 at the age of forty-nine years.

DOUGLAS D. H. MARCH, curator of the Old Panama Zoological Garden, died of a snake bite on April 3 at the age of fifty-two years.

IVAN GUBKIN, explorer and vice-president of the Russian Academy of Sciences, died on April 21 at the age of sixty-eight years.

DR. PAUL EUGENE LINEBACK, professor of microanatomy at Emory University, died on February 8 at the age of fifty-eight years.

PROFESSOR JAMES WILLIAM EDINGTON, professor of bacteriology and director of the Public Health Bacteriological Laboratory of the University of Sheffield, England, died on April 8 from injuries received in an automobile accident. He was fifty-four years of age.

DR. ERNEST H. HANKIN, bacteriologist, retired, of the Indian Service of the British Government, died at the age of seventy-four years on March 29.

# SCIENTIFIC EVENTS

## GRANTS FOR RESEARCH OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

UPON recommendation of the Committee on Grants, consisting of Drs. J. G. Lipman (Agriculture), *chairman,* McKeen Cattell (Medical Sciences), Moses Gomberg (Chemistry), G. H. Parker (Zoology), F. K. Richtmyer (Physics), Joel Stebbins (Astronomy), Sam F. Trelease (Botany), and A. T. Poffenberger (Psychology), the council of the association has awarded grants in aid of research from the $2,000 fund appropriated for the year 1939 as follows:

Harold C. Bold, Vanderbilt University, for studies of the algal flora of the Highlands of North Carolina and in other portions of the southern Appalachian Mountains, $150.

Kendall B. Corbin, University of Tennessee Medical College, for investigation of the source and nature of the proprioceptive components of the cranial nerves, $200.

Frank H. J. Figge, University of Maryland, for continuation of investigations on the intra-cellular factors controlling enzymatic pigment formation, $250.

Arthur H. Graves, Brooklyn Botanic Garden, for attempts to develop, by breeding, a blight-resistant chestnut tree of a type suitable for timber to replace the now practically extinct American chestnut—*Castania dentata,* $200.

F. R. Hunter, Rhode Island State College, to study the relationship between the respiratory activity of the cell and its selectively permeable properties, $65.

Daniel Linehan, Weston College, to make a seismological study of the earthquake near Lowell, Massachusetts, of June 23, 1938, $80.

Isabelle W. Pfeiffer, Yale University, to aid in a histological study of the corpora allata of the grasshopper, *Melanoplus differentialis,* in correlation with various physiological conditions, particularly those relating to moulting and reproduction, $75.

Christianna Smith, Mount Holyoke College, for the study of the rat embryonic liver in its hematopoietic stage by the tissue culture method to elucidate the origin and differentiation of red blood corpuscles, $100.

M. L. Pool, Ohio State University, to construct a beta-ray spectrograph suitable for measuring the beta-ray spectra of artificial radioactive nuclei; the gamma-ray spectra to be measured by Compton recoil electrons, $300.

H. S. Reed, University of California, Berkeley, to provide help for clerical and bibliographical assistance, for photostats, and possible short trips to other libraries, in connection with preparation of a book on the history of the plant sciences, $150.

Elizabeth S. Russell, Jackson Laboratory, to continue a study of the genetics, histology and physiology of the various benign and malignant tumors in the fruit-fly, *Drosophila melanogaster,* $230.

Sherwin F. Wood, Los Angeles City College, to determine insect reservoirs for *Trypanosoma cruzi* Chagas in the state of Texas and the virulence of these insect infections for white-footed mice, $200.

## SUMMER BOTANICAL MEETINGS IN VIRGINIA, WISCONSIN AND CALIFORNIA

DR. GEORGE S. AVERY, JR., secretary of the Botanical Society of America, writes that there will be three regional meetings of the society during June, the first at the Mountain Lake Biological Station, Mountain Lake, Virginia, on June 15, 16 and 17; the second at the University of Wisconsin on June 21, 22 and 23, and the third at Stanford University from June 26 to July 1.

The Mountain Lake gathering will be a joint meeting with the American Society of Plant Taxonomists, the Sullivant Moss Society, the American Fern Society, the Southern Appalachian Botanical Club and the Committee on Virginia Flora. The University of Virginia and the Virginia Polytechnic Institute will be joint hosts for this meeting. Field trips will be made into the surrounding mountain region during the day-time, and evening meetings will be held on the grounds of the Biological Station, and on the campus of the Virginia Polytechnic Institute. Accommodations with meals will be available in Blacksburg at $3 a day. At the Mountain Lake Biological Station, meals and lodging will be $2.00. Reservations may be made at either place by addressing Professor A. B. Massey, Blacksburg, Va.

The University of Wisconsin will be the host for the second meeting. This will be a joint meeting with the American Phytopathological Society, the American Society of Plant Physiologists, the American Society of Plant Taxonomists and the Mycological Society of America. Both field and formal meetings will be held. Accommodations will be available at various hotels at minimum rates of from $2.50 to $4. The University Club will have a few rooms available. Reservations may be made directly with the hotels or with the University Club.

Dr. Ira L. Wiggins, secretary of the Pacific Section, announces that the Stanford University gathering will be a joint meeting with the Pacific Division of the American Association for the Advancement of Science. It will include joint symposia and other meetings with the Western Sections of the American Society of Plant Physiologists, the Ecological Society of America and the American Society of Plant Taxonomists. A field trip is arranged for Ano Nuevo Point, an area about forty miles from Stanford where coastal sand dunes, a partially submerged deposit of peat, vegetation along a brackish lagoon, etc., can be examined. Housing accommodations will be available in the dormitories at the rate of $2.00 per day for the first three days, and $1.75 thereafter. Reservation requests should be addressed to Miss Anastasia Doyle, Box 1772, Stanford University. Three hotels in Palo Alto, a mile from the university, offer accommodations for approximately forty-five transient guests at rates varying from $1.25 to $4. Early reservations are urged because of the demand for rooms during the Golden Gate Exposition. Meals may be obtained at the Stanford Union. Full information will be mailed to members at an early date.

## MEDALS OF THE FRANKLIN INSTITUTE

THE complete list of recipients in 1938 of the various medals awarded annually by the Franklin Institute, Philadelphia, Pa., as recommended by its Committee on Science and the Arts, has been announced by Dr. Henry Butler Allen, secretary of the institute, as follows:

*The Franklin Medal*, awarded annually from the Franklin Medal Fund, founded January 1, 1914, by Samuel Insull, Esq., "to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the Institute, acting through its Committee on Science and the Arts, have done most to advance a knowledge of physical science or its applications." To Edwin Hubble, Ph.D., D.Sc., LL.D., Mount Wilson Observatory, Carnegie Institution of Washington, Pasadena, "In recognition of his extensive study of the nebulae, particularly those outside our galaxy, as a result of which the dimensions of observed space have been greatly increased."

*The Franklin Medal* posthumously to Albert Sauveur, Sc.D., D.Eng., professor emeritus of metallurgy and metallography, Harvard University, "In recognition of his outstanding work in the science of metallography and of his many contributions to this branch of metallurgy which have been in a large measure responsible for changing the heat treatment of steel from an art to a science."

*The Edward Longstreth Medal*, founded in 1890 by Edward Longstreth, of Philadelphia, retired member of the Baldwin Locomotive Works, for the encouragement of invention. To Arthur C. Hardy, Sc.D., professor of optics and photography, Massachusetts Institute of Technology, "In consideration of the development of an accurate and reliable instrument which has greatly expedited research in the field of color, both in theory and in its commercial applications." To Jesse E. Stareck, Ph.D., Waterbury, Conn., "In consideration of the development of a new technique for the study of electrode phenomena encountered in the electrolysis of water solutions and the discovery of a new method applicable to the art of coloring metals." To John Strong, Ph.D., assistant professor of physics in astrophysics, California Institute of Technology, and to Robley Cook Williams, Ph.D., department of astronomy, University of Michigan, "In consideration of their independent development and improvement of a process for coating astronomical mirrors with a layer of metallic aluminum deposited thereon by evaporation in vacuo."

*The John Price Wetherill Medal*, founded in 1925 by the family of John Price Wetherill, to be awarded for discovery or invention in the physical sciences, or for new and important combinations of principles or methods already known, to William Albert Hyde, director of research, Leon J. Barrett Company, Worcester, Mass., "In consideration of his discovery and development of a process for the centrifugal impregnation of objects which has materially reduced the time necessary for impregnation as compared with the prior art."

*The George R. Henderson Medal*, founded in 1924 by Mrs. Virginia P. C. Henderson, in memory of her husband, George R. Henderson, consulting mechanical engineer connected with Baldwin Locomotive Works. He was also a long-time member of the Franklin Institute and served as chairman of its Committee on Science and the Arts and

as a member of its Board of Managers. The medal is awarded for distinguished contributions in the field of railway engineering. This year it will be presented to Ralph Budd, president, Chicago, Burlington and Quincy Railroad Company, Chicago, Illinois, "In consideration of his engineering ability, vision and courage in carrying out railroad construction in difficult mountainous terrain in the Northwestern part of our country, and of his other contributions in the field of railway engineering."

*The Louis E. Levy Medal*, founded in 1923 by the family of Louis E. Levy, Philadelphia, a member of the Committee on Science and the Arts of the Franklin Institute at the time of his death, who had previously served the institute as a member of the Board of Managers for twelve years and a vice-president for three years, is awarded "to the author of a paper of especial merit, published in the *Journal* of the Franklin Institute, preference being given to one describing the author's experimental and theoretical researches in a subject of fundamental importance." It will be given to Kalman John DeJuhasz, associate professor of engineering research, Pennsylvania State College, "For his article entitled 'Graphical Analysis of Surges in Mechanical Springs,' which appeared in the October and November, 1938, issues of the *Journal* of the Franklin Institute."

*The Howard N. Potts Medal*, founded, by will, in 1906, by Howard N. Potts, a life member of the institute and a member of the Bar in Philadelphia, is awarded for "distinguished work in science or the arts; important development of previous basic discoveries; inventions or products of superior excellence or utilizing important principles." It will be awarded to Newcomb K. Chaney, Ph.D., director of research, United Gas Improvement Company, Philadelphia, Pa., "In consideration of his original and successful work in the hitherto uncharted field of carbon activation," and to H. Jermain Creighton, Sc.D., professor of chemistry, Swarthmore College, Swarthmore, Pa., "In consideration of his distinguished work in developing a process for the electrolytic reduction of simple sugars on a large scale."

*The Elliott Cresson Medal*, founded in 1848 by Elliott Cresson, of Philadelphia, Pa., a philanthropist and successful merchant who lived from 1796–1854, is awarded for recognition of distinguished contributions in the realm of physical science. It will be awarded to George Ashley Campbell, Ph.D., Upper Montclair, N. J., retired research engineer, American Telephone and Telegraph Company, "In consideration of his lifelong study of the theory of electric circuits, resulting in notable contributions to the science that underlies telephony and to inventions of fundamental importance in the art." To John R. Carson, Sc.D., research mathematician, Bell Telephone Laboratories, Inc., New York, New York, "In consideration of outstanding contributions to the art of electrical communication," and to Charles Vernon Boys, F.R.S., LL.D., London, England, "In recognition of the scientific achievements of Sir Charles Vernon Boys, which have furnished scientists with new and remarkably precise methods for making measurements in gravitation, in sound, in heat, in radiation, in current and static electricity so refined as to render possible the weighing of the earth, the determination of the radiant energy coming to us from the stars, the photography of the speeding bullet and the immobilization, even, of the lightning flash itself."

*Certificate of Merit*, presented jointly to Percy Russell, D.D.S., Wilmington, Delaware, and E. Burke Wilford, president, Pennsylvania Aircraft Syndicate, Philadelphia, Pa., "In consideration of the development and application of a simple means of regulating and controlling the speed of small electric motors."

The presentation of the medals and certificates will be made at 3:30 P.M., on the afternoon of Wednesday, May 17, in Franklin Hall, at formal exercises presided over by Philip C. Staples, president of the Franklin Institute. At this session Dr. Hubble will read an original paper on "The Motion of the Stellar System Among the Nebulae." Mrs. Albert Sauveur will be present to accept the award of the Franklin Medal to Dr. Sauveur.

At 7:30 P.M., on the evening of the same day, a subscription dinner in honor of the medalists will be held in Franklin Hall.

## MEDALS OF THE NATIONAL ACADEMY OF SCIENCES

PRESENTATION of the medals of the National Academy of Sciences was made at the annual dinner of the academy on April 25. These were as follows:

*Agassiz Medal for Oceanography*, awarded to Harald Ulrik Sverdrup, of the Scripps Institution of Oceanography of the University of California, La Jolla, for his personal oceanographic explorations in Arctic regions and his numerous contributions to physical oceanography and the interrelations between the sea and the atmosphere. The presentation address was made by Dr. T. Wayland Vaughan, emeritus professor of oceanography of the University of California and emeritus director of the Scripps Institution, who was chairman of the committee at the time the award was recommended to the academy.

*Daniel Giraud Elliot Medal for 1933 and Accompanying Honorarium of $200*, awarded to Richard Swann Lull, of the Peabody Museum of Natural History, Yale University, in recognition of his work entitled: "A Revision of the Ceratopsia or Horned Dinosaurs," published in the *Memoirs* of the Peabody Museum of Natural History. The presentation address was made by Dr. William Berryman Scott, emeritus professor of paleontology of Princeton University.

*Daniel Giraud Elliot Medal for 1934 and Accompanying Honorarium of $200*, awarded to Theophilus Shickel Painter, of the University of Texas, in recognition of his work on the chromosomes of the salivary glands in Drosophila in relation to the problems of mutation and genetics, published in *Genetics* and the *Journal of Heredity* in 1934. The presentation address was made by Dr. Ross G. Harrison, of Yale University, chairman of the committee on the Daniel Giraud Elliot Fund.

*The John J. Carty Medal and Award for the Advance-*

*ment of Science,* consisting of a gold medal, bronze replica, certificate and $3,000 in cash, awarded to Sir William Bragg, of the Royal Institution, London. Sir William is distinguished by his fundamental work in x-ray crystal analysis. He has shown how to reveal the constitution of crystalline forms and accurately measure them, and his studies have given birth to a new tool which is bringing to light important facts regarding such complex structures as the larger organic molecules. Dr. Frank B. Jewett, chairman of the Committee on the Carty Fund, stated the reasons for the award, and Dr. A. H. Compton, of the University of Chicago, spoke on Sir William's work.

## ELECTIONS OF THE NATIONAL ACADEMY OF SCIENCES

AT the annual meeting of the National Academy of Sciences, held in Washington on April 24, 25 and 26, Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, was elected president for a term of four years, to succeed Dr. Frank R. Lillie, emeritus professor of zoology of the University of Chicago, who will retire on June 30.

New members of the academy were elected as follows:

Gregory Breit, professor of physics, University of Wisconsin.

Detlev Wulf Bronk, Johnson professor of biophysics and director of the Johnson Foundation, University of Pennsylvania.

William Bosworth Castle, associate professor of medicine, Harvard Medical School, director of the Thorndike Memorial Laboratory, Boston City Hospital.

Frederick Gardner Cottrell, president, Research Associates, Incorporated, Washington, D. C., consulting chemist, Bureau of Chemistry and Soils.

Frederick Parker Gay, professor of pathology and bacteriology, College of Physicians and Surgeons, Columbia University.

Albert Baird Hastings, Hamilton Kuhn professor of biochemistry, Harvard University.

Vladimir Nikolaevich Ipatieff, research director of the Universal Oil Products Company, professor of chemistry, Northwestern University.

Merkel Henry Jacobs, professor of general physiology, University of Pennsylvania.

Zay Jeffries, General Electric Company, Cleveland, Ohio.

Donald Forsha Jones, geneticist, Connecticut Agricultural Experiment Station, New Haven.

George Bogdan Kistiakowsky, professor of chemistry, Harvard University.

Warren Judson Mead, professor and head of the department of geology, Massachusetts Institute of Technology.

Oscar Riddle, investigator, department of genetics, Station for Experimental Evolution, Carnegie Institution, Cold Spring Harbor, N. Y.

Adolph Hans Schultz, associate professor of physical anthropology, School of Medicine, the Johns Hopkins University.

Philip Edward Smith, professor of anatomy, College of Physicians and Surgeons, Columbia University.

Foreign associates elected were:

Sir Joseph Barcroft, professor of physiology, the University of Cambridge.

Sir William Bragg, director, the Royal Institution of Great Britain and Fullerian professor of chemistry and director of the Faraday Research Laboratory.

Dr. F. A. Vening Meinesz, professor of geodesy and cartography, the University of Utrecht.

Dr. Frederick E. Wright, of the Geophysical Laboratory, Carnegie Institution of Washington, was reelected home secretary for a term of four years, and Dr. Charles August Kraus, professor of chemistry at Brown University, and Dr. Alfred Newton Richards, professor of pharmacology at the University of Pennsylvania, were elected members of the council to succeed Dr. Simon Flexner, director emeritus of the Rockefeller Institute for Medical Research, and Dr. J. B. Whitehead, director of the school of engineering of the Johns Hopkins University.

# SCIENTIFIC NOTES AND NEWS

THE John L. Lewis Prize of the American Philosophical Society has been conferred on Dr. Henry Norris Russell, professor of astronomy and director of the observatory at Princeton University, "in appreciation of his contribution on 'stellar energy,' at the society's symposium on astrophysics in February." The presentation was made by Dr. Harlow Shapley, director of the Harvard College Observatory, at the annual dinner of the society on April 22. Dr. Roland S. Morris, formerly United States Ambassador to Japan and president of the society, presided. The speakers included Dr. Vannevar Bush, president of the Carnegie Institution of Washington; Dr. Victor G. Heiser, of the International Leprosy Commission, and Professor Jesse S. Reeves, of the University of Michigan.

AT the closing session of the meeting in Washington of the American Geophysical Union, Dr. William Bowie was made the first recipient of a newly established Bowie Medal, named in his honor, "for distinguished attainment and outstanding contribution to the advancement of cooperative research in fundamental geophysics." Dr. Bowie joined the U. S. Coast and Geodetic Survey in 1895 and from 1909 until his retirement in 1936 was chief of the Division of Geodesy.

THE British Society of Antiquaries, London, will

award its gold medal this year for distinguished services to archeology to Dr. Haakon Shetelig, keeper of the Bergen Museum. He received the medal at the anniversary meeting, which was held at Burlington House on April 27.

THE prize of $1,000, established by Mead Johnson and Company, was awarded at the Toronto meeting of the American Institute of Nutrition to Dr. C. A. Elvehjem, professor of agricultural chemistry at the University of Wisconsin, in recognition of his work with nicotinic acid as a cure for pellagra.

THE sixth award of the Edward Goodrich Acheson Medal and the $1,000 prize of the Electrochemical Society was presented at the Columbus meeting on April 26 to Dr. Francis Cowles Frary, director of the Research Laboratories of the Aluminum Company of America and known for his achievements in the metallurgy of aluminum. Previous recipients of the award are: Dr. Edward Goodrich Acheson, for his work on artificial graphite; Dr. Edwin F. Northrup, for the invention of the high frequency electric furnace; Dr. Colin G. Fink, for his contributions to electrochemistry; Dr. Frank J. Tone, for his work on carborundum, and Dr. Frederick M. Becket, for his contributions to electrometallurgy.

PROFESSOR CLAUDE RIGAUD has received the award of the Katherine Berkan Judd Prize of the Memorial Hospital for the Treatment of Cancer and Allied Diseases for the year 1938. The prize, which carries a stipend of $1,000, is for his "pioneer contributions in the field of radiophysiology and therapy." Dr. Rigaud was for many years director of the Curie Institute, Paris, and since his retirement has been engaged in research in the Pasteur Institute, Paris.

THE A. W. Hoffmann Memorial Medal has been awarded by the German Chemical Society to Dr. Albert Szent-Györgyi, professor of medical chemistry at Szeged, Hungary.

THE Lobatchewsky Prize of the Mathematical Institute of Kazan has been awarded to Professor Élie Cartan, of the University of Paris.

PETER P. T. SAH, professor of organic chemistry at the Catholic University, Peking, China, has been elected to the Kaiserlich Deutsche Akademie der Naturforscher in recognition of his work in vitamin research.

M. JACQUES DUCLAUX, professor of general biology in the Collège de France, Paris, has been elected a free academician of the Paris Academy of Sciences, in succession to the late M. d'Ocagne.

DR. BERTHOLD HATSCHEK, professor of zoology at the University of Vienna, celebrated on April 3 the eighty-fifth anniversary of his birthday.

AT the Toronto meeting of the Federation of American Societies for Experimental Biology, Dr. Oscar Henry Plant, professor of pharmacology of the University of Iowa, was elected president of the American Society for Pharmacology and Experimental Therapeutics and, by a system of rotation among the societies, also became chairman of the executive committee of the federation. The next meeting of the federation will be held in New Orleans.

AT the annual meeting of the Electrochemical Society, held at Columbus, Ohio, the following officers were elected: *President,* H. Jermain Creighton, Swarthmore College; *Vice-presidents,* D. A. Pritchard, Montreal; Alexander Lowy, Pittsburgh; J. D. Edwards, New Kensington, Pa.; *Managers,* C. E. Williams, Columbus; K. G. Soderberg, Detroit; J. A. Lee, New York City; *Treasurer,* Robert M. Burns, New York City; *Secretary,* Colin G. Fink, Columbia University.

IT is stated in *Nature* that at a plenary session of the Academy of Sciences of the U.S.S.R. recently held in Moscow the following officers were elected: *President,* V. L. Komarov; *Vice-presidents,* O. J. Schmidt, the late I. M. Gubkin, E. A. Chudakov, A. A. Bogomolets, A. J. Vishinsky, T. D. Lysenko, V. N. Obrazcov, A. E. Fersman. The secretaries of the eight newly constituted departments of the academy, elected at a previous session of the academy, become *ex-officio* members of the Presidium. They are: Department of Economics and Law, E. S. Varga; Department of Technical Sciences, V. P. Nikitin; Department of History and Philosophy, A. M. Deborin; Department of Geology and Geography, P. I. Stepanov; Department of Biology, L. A. Orbeli; Department of Physico-Mathematical Sciences, A. N. Kolmogorov; Department of Languages and Literature, I. I. Meshchaninov; Department of Chemistry, A. N. Bakh.

PROFESSOR ALPHEUS G. WOODMAN, professor of chemistry at the Massachusetts Institute of Technology, has been made emeritus professor.

DR. TRACY J. PUTNAM, professor of neurology at the Harvard Medical School and neurologist-in-chief of the Boston City Hospital, has been appointed professor of neurology and neurosurgery at the Columbia University School of Medicine. Dr. Putnam will also be the director of services of neurology and neurosurgery at the Neurological Institute of the Columbia-Presbyterian Medical Center. Dr. Vernon W. Lippard, director of the Commission for Study of Crippled Children of the City of New York, has been appointed assistant dean of the school. Drs. Charles A. Flood and Lawrence W. Sloan have resigned as assistant deans to enter private practice.

ANNOUNCEMENT has been made of a number of pro-

motions and appointments at the Yale School of Forestry, effective on July 1. These staff changes have been occasioned by the retirement of Dean Henry S. Graves and the death of Professor Ralph C. Bryant. As previously announced, Professor Samuel J. Record has been named dean of the school. He will also carry the title of Pinchot professor of forestry. Dr. George A. Garratt, associate professor of forest products, has been appointed Manufacturers' Association professor of lumbering, to fill the vacancy created by the death of Professor Bryant. Dr. Harold J. Lutz, assistant professor of forestry since 1933, has been promoted to an associate professorship. Dr. Walter H. Meyer, professor of forest management at the University of Washington, has been appointed associate professor of forestry, to fill the teaching vacancy created by the retirement of Dean Graves. Robert T. Clapp has been promoted to an assistant professorship, on the Charles Lathrop Pack Foundation, and will serve as director of the Yale Forests and of the summer term of the School of Forestry, as well as giving instruction during the regular college year. Robert W. Hess, assistant professor of forestry at the University of Maine, has been appointed assistant professor of forest products, to fill the vacancy resulting from Professor Garratt's promotion to the professorship of lumbering. Professor Hess was formerly associated with the University of Arkansas.

DR. ALFRED C. CALLEN, of the University of Illinois, has been appointed head of the department of mining engineering and dean of the College of Engineering at Lehigh University. Dr. Bradford Willard, of the Pennsylvania Topographical and Geologic Survey, has been appointed head of the department of geology, and Professor Gilbert E. Doan, of the faculty, head of the department of metallurgical engineering. Relinquishing their administrative work under an age rule of the board, but continuing on the teaching faculty are: Professor Bradley Stoughton, dean of the College of Engineering and head of the department of metallurgical engineering; Professor Benjamin L. Miller, head of the department of geology, and Professor Howard Eckfeldt, head of the department of mining engineering.

DEAN ROBERT C. DISQUE, of the School of Engineering of Drexel Institute of Technology, has been appointed educational consultant in planning and carrying out the cooperative system of education in the Institute of Technology to be established at Northwestern University through the $6,735,000 gift of the Walter P. Murphy Foundation. He will assume the position left vacant by the recent death of Dean Herman Schneider, of the University of Cincinnati, founder of the cooperative plan, who was originally selected as adviser to the new institute by Northwestern University and the Walter P. Murphy Foundation.

DR. JAMES G. HORSFALL, chief in research in plant pathology at the New York State Experiment Station at Geneva since 1929, has resigned to become head of the department of plant pathology and botany at the Connecticut Agricultural Experiment Station at New Haven.

M. J. Goss, of the Industrial Farm Products Research Division of the Bureau of Chemistry and Soils, has been appointed technical assistant in the general organization of the Regional Research Laboratories which are being established by the U. S. Department of Agriculture.

DR. NORMAN W. KRASE, professor of chemical engineering at the University of Pennsylvania, has been appointed by the E. I. du Pont de Nemours and Company to take charge of all semi-works operations for the ammonia department of the chemical division, with headquarters at the Experimental Station, Wilmington, Del. He will begin his new work at the end of the present academic year.

DR. JUAN NEGRIN, formerly professor of physiology at the University of Madrid, who was premier of the Spanish Republican Government, sailed for New York on April 26.

FRANKLIN C. MCLEAN, professor of pathological physiology at the University of Chicago, writes: "Professor Otto Loewi has been released from Germany. He may be addressed in care of Club de la Fondation Universitaire, Rue d'Egmont, Brussels. Before being released he was stripped of all his property, both inside of and outside of Germany, including his Nobel prize money, which had never been in either Austria or Germany. Mrs. Loewi is still detained in Germany."

COLONEL JOSEPH F. SILER, director of the Army Medical School, delivered the annual Kober Lecture at Georgetown University Medical School, Washington, D. C., on March 28, on a new vaccine for typhoid developed by the army. He was presented with a check for $500, provided under the terms of the Kober Foundation.

THE John Torrey lecture in botany of the Torrey Botanical Club was delivered by Dr. P. R. White, of the Rockefeller Institute for Medical Research, Princeton, New Jersey, before the club and the Columbia Institute of Arts and Sciences on Friday evening, April 21. He spoke on "Tissue Cultures in Plants."

DR. GEORGE B. KISTIAKOWSKY, professor of chemistry, Harvard University, will deliver the Edgar Fahs Smith Memorial Lecture at the University of Pennsylvania on May 26. His subject will be "Energetics of Some Organic Molecules."

DR. WALTER B. CANNON, George Higginson professor of physiology at Harvard University and president of the American Association for the Advancement of Science, spoke on "Serendipity" or "An Accidental Sagacity" at the second annual meeting of the Wellesley Chapter of Sigma Xi on April 28.

DR. ALBERT D. MEAD, professor of biology, emeritus, will give the Graduate School Convocation address at Brown University on June 17. His subject will be "The Species Complex."

THE Association for Research in Human Heredity meets at the New York Academy of Medicine on May 5 at 8:30 P.M. Dr. Alan Gregg, of the Rockefeller Foundation, is chairman. The speakers and their subjects are Dr. Nolan D. C. Lewis, the New York State Psychiatric Institute, "Evaluation of Present Research on the Genetics of Mental Disease," and Dr. Leslie T. Webster, the Rockefeller Institute for Medical Research, "The Role of Inborn Resistance in Infectious Disease."

A MEDICAL center, built at a cost of $1,000,000, on Mt. Scopus, Jerusalem, will be dedicated on May 9. Funds for the building were provided by the American Jewish Physicians' Committee and by Hadassah, the Women's Zionist Organization of America.

THE new observatory at the University of Glasgow was opened on April 18 by Sir Arthur Eddington, Plumian professor of astronomy at the University of Cambridge and director of the Cambridge Observatory. Sir Arthur was introduced by Sir Hector Hetherington, principal and vice-chancellor of the university, who said that it was the third observatory of the department of astronomy. It would be used not so much for observation as for instruction and the training of students in the use of astronomical instruments. The new observatory consists of a laboratory, an astronomy room, a dome for the 7-inch refractor and a house for the transit instrument. Before the opening ceremony Sir Arthur lectured on "The Expansion of the Universe."

# DISCUSSION

## THE FIRST EXPERIMENT IN PLANT PHYSIOLOGY

ACCORDING to texts in general botany and plant physiology and to a representative series of books on the history of biology and the history of botany, the first experiment in plant physiology was performed by Van Helmont in the seventeenth century, the familiar and oft-cited five-year test, during which a five-pound willow shoot grew to a weight of one hundred and sixty-nine pounds, while its supporting soil, starting at two hundred pounds, lost only two ounces. That Van Helmont was first to perform this experiment is so generally accepted that a divergent opinion was a matter of special interest. According to Charles Singer ("From Magic to Science," 1928), credit for this experiment really belongs to a man of two centuries before Van Helmont, Nicholas Krebbs (1401–1464), usually set down as Cusanus or Cardinal Nicholas de Cusa (Cues or Kues). Singer writes: "He records a careful experiment of a growing plant—afterwards pirated by the seventeenth century writer, Van Helmont (1577–1644)—proving that it absorbs something of weight from the air. This is the first biological experiment of modern times, and incidentally the first formal proof that air has weight."

As a matter of interest and record, translations of the statements of Cusanus and of Van Helmont are reproduced below for comparison. The Van Helmont excerpt was made by E. J. Russell, as quoted in *Plant Physiology* (1929). The Cusanus translation comes from an English edition of a small part of his writings published in 1650, six years after Van Helmont's death, and bearing the following title page:

> The Idiot, in four books. The first and second of Wisddome. The third of the Minde. The fourth of statick Experiment. or experiments of ballance. By the famous and learned C. Cusanus. London. Printed for William Leake, and are to be sold at the signe of the Crowne in Fleet-Street, between the two Temple Gates, 1650.

*From Van Helmont:*

I took an earthen vessel in which I put 200 pounds of soil dried in an oven, then I moistened with rain water and pressed hard into it a shoot of willow weighing five pounds. After exactly five years the tree that had grown up weighed 169 pounds and about three ounces. But the vessel had never received anything but rain water or distilled water to moisten the soil when this was necessary, and it remained full of soil, which was still tightly packed, and, lest any dust from outside should get into the soil, it was covered with a sheet of iron coated with tin but perforated with many holes. I did not take the weight of the leaves that fell in the autumn. In the end I dried the soil once more and got the same two hundred pounds that I started with, less two ounces. Therefore the 164 pounds of wood, bark, and root arose from the water alone.

*From Cusanus:*

*Orator.* "There is a saying, that no pure element is to be given, how is this proved by the Ballance?"

*Idiot.* "If a man should put an hundred weight of earth into a great pot, and then take some Herbs, and Seeds, & weigh them, and then plant or sow them in that

pot, and then should let them grow there so long, untill he had successively by little and little, gotten an hundred weight of them, hee would finde the earth but very little diminished, when he came to weight it againe: by which he might gather, that all the aforesaid herbs, had their weight from the water. Therefore the waters being ingrossed (or impregnated) in the earth, attracted a terrestreity, and by the operation of the Sunne, upon the Herb were condensed (or were condensed into an Herb.) If these Herbs bee then burn't to ashes, mayest thou not guesse by the diversity of the weights of all: How much earth thou foundest more than the hundred weight, and then conclude that the water brought all that? For the Elements are convertible one into another by parts, as we finde by a glass put into the snow, where we shall see the aire condensed into Water and flowing in the glass. So wee finde by experience, that some water is turned into stones, as some is into Ice; and there is in some fountaines a hardening and petrifying vertue, which turns the things that are put into them, into stone. For so say they, there is a certain water found in *Hungary*, which through the power of the vitriall which is in it, turneth Iron into Copper; for by such powers and vertues, it is manifest that the waters are not purely elementary, but elementated. And it were pleasant to have the weights of all these waters, of such divers vertues, that by the diversity of their weights in aire & oyle, one might come the nearer to the conjectures of their vertues.''

Whether Cusanus actually performed one or more specific experiments with plants of the type indicated probably can not be certainly determined. It is obvious, however, that he had a true concept of experimental method long before any one else is known to have put it to trial, so far as botany is concerned. That he probably did actually perform many tests with balances seems indicated by the circumstantiality of the phraseology. This opinion seems further confirmed by the fact that this plant experiment was not merely alone; the text contains others so factually correct that they practically eliminate the possibility that his citation of them may have been due to *a priori* reasoning. Two others are given below for their evidence of Cusanus's objective and inductive point of view.

*Orator.* ''Might not the breath of a man be so weighed?''

*Idiot.* ''There is one weight of the same man, when he draws in or holds his breath, another when he breathes it out; one weight of a man whilest he lives, another when he is dead; And so in all living things. And therefore it were good to have these differences noted, in divers living things, and divers men, and divers ages of men, that so by conjecture, a man might ascend to the weight of the vitall spirits.'' . . .

*Orator.* ''How may the strength of a man be known by this means?''

*Idiot.* ''Make a paire of scales even, then let a man lay hold of one of them, and in the other put as much weight as he can by the utmost of his strength pluck up from the ground till the balance be even: (which will be found more true (say I) if he have a rest to stay one or both his feet against) then take the weight of that which he hath pulled up, and deducting the weight of the man himself, all the remainder of the weight is portioned to his strength.''

When all the circumstances are considered, the question of credit for the first experiment in plant physiology seems to be resolvable about as follows: The works of Cusanus were extant and perhaps fairly well known in the seventeenth century, but his chief reputation then, as to-day, came from his contributions in the field of cosmology and philosophy, known from his influence on Giordano Bruno. In his experimentation, he had been so far ahead of his time that little attention had been paid to such matters of precision. By the seventeenth century, however, the intellectual soil had been cultivated further. Harvey had demonstrated the circulation of the blood. Francis Bacon had strongly advocated the use of the inductive method, and in his Sylva Sylvarum (1627) had described "ten centuries" of experiments, including not a few in plant physiology. Some of these are given in general terms, like the Cusanus account above, but others are as circumstantial as the Van Helmont experiment, and some even include carefully stipulated controls. Botanists will find in this Bacon work the forerunners of a variety of plant experiments. Since Sylva Sylvarum, published posthumously, antedated Van Helmont apparently by twenty-four years, it would appear that the question of priority for the first experiment in plant physiology lies between three men, rather than between two, with Van Helmont probably third in the series.

RALPH C. BENEDICT

BROOKLYN COLLEGE AND
BROOKLYN BOTANIC GARDEN, BROOKLYN

## METHOD OF ENTRANCE OF CERTAIN FISH INTO AN ESTUARY

THE factors responsible for the migration of fish into an estuary are not as yet fully understood. Various theories, some of them incorporating an "instinctive" behavior, have been put forward to explain certain phases of these migrations, but scientific investigation tends to discredit such theories, and places instead great importance on the influence of certain purely environmental factors.[1,2,3,4]

The mouth of the five-mile long tidal part of the Margaree River in Nova Scotia is of such a nature that it offers an excellent opportunity for studying the passage of certain fish into and out of the estuary. The common estuarine fish of this river is the stickleback, *Gasterosteus aculeatus*, and large numbers are

[1] A. G. Huntsman, SCIENCE, 85: 313–314, 1937.
[2] E. B. Powers, *Publ. Puget Sound Biol. Sta.*, 3: 1–22, 1921.
[3] V. E. Shelford and E. B. Powers, *Biol. Bull.*, 28: 315–334, 1915.
[4] H. B. Ward, *Ann. Mag. Nat. Hist.*, 10: 6, 18–36, 1930.

carried from the estuary periodically with the outflowing tide. They gather at the ends of the breakwaters forming the narrow harbor mouth, and eventually, when the strength of the current has decreased sufficiently, make their way against it back into the estuary.

Two of the factors found to influence the entrance of sticklebacks into this estuary are (1) current and (2) low salinity, or something associated with it. Lyon[5] has described the orientation of fish in a current, and states that the normal tendency for a fish is to orient itself against the direction of current flow. Sticklebacks at the mouth of the Margaree exhibited just such a behavior. If they left their position in slowly moving water at the end of the breakwater to breast faster currents emerging from the river, they were carried back out again, but if the velocity of the outflowing water was not more than 1½ feet per second, their "cruising speed" was sufficient to take them into the harbor. At the turn of the tide, when the water became motionless, their orderly orientation was destroyed. With the commencement of the flooding tide, fish were seen to turn about and, stemming the current, make their way out of the estuary, which recalls Rutter's[6] account of the behavior of migrating quinnat salmon in San Francisco Bay. Such actions suggest the lack of any purposeful behavior in the migration of these fish, for they might be expected to swim in and regain their natural habitat at such times when entry could be most easily accomplished.

Sticklebacks at the mouth of the estuary were found to be attracted by river water. At the end of one of the breakwaters, they were frequently subjected to a second current of water in addition to that flowing from the estuary. Depending upon the direction of the wind, this second current consisted either of salt water from outside or of fresher river water which had left the estuary a short time before. In the latter case, fish would enter it in much the same manner that they breasted the current from the river, even though it did not lead into the estuary. When it was salt water that produced the current, fish shunned it. The results of an experiment performed with sticklebacks in a trough, in which they were subjected to currents of fresh and salt water of the same temperature entering at one end, gave added support to the indication that river water is attractive to these fish. Of the three dozen individuals used in the trough experiment, there were always twice as many fish in the current of river water as there were in the salt. *Menidia* and *Fundulus* reacted similarly. Whether the influence of the fresher water was due merely to its lower salt content or perhaps to the fact that it contained materials from the land was not determined.

HAROLD M. ROGERS

UNIVERSITY OF TORONTO

## COMPOUND WORDS IN PRESENT-DAY ENGLISH

I WONDER if philologists and students of style have noticed that, at least in scientific writing, the English language is rapidly acquiring a facility in forming compound words comparable to that possessed by ancient Greek and contemporary German? Such is undoubtedly the fact. As yet, our technique is rather awkward; the elements of a compound are written as separate words, and the resultant construction, if taken literally, would often defy parsing. But its essential nature is quite clear.

The new usage seems to be wholly unpremeditated and instinctive. There is something in the air; though trained in quite different methods, I find myself unconsciously eliminating prepositions and compressing phrases into compound words.

Thirty years ago every one, probably, would have written "Department of Biology." Now half the colleges in the United States have "Biology Department," or the like, on their stationery. Certainly, thirty years ago no one would have put forth such a title as "Cost Analysis of Scholarly Periodical Printing." Then it would have read: "An Analysis of the Cost of Printing Scholarly Periodicals." In time, as we become more definitely conscious of what we are doing, it may read: "Costanalysis of Scholarlyperiodicalprinting."

The whole phenomenon may serve as an illustration of the mysterious manner in which changes in language (and some other things) take place. Learned men in any number might have argued for years that compounds were convenient, concise and generally desirable in English, and have produced no more effect than have the advocates of "reformed" spelling. But, all at once, there comes some sort of inner urge—some mental epidemic—and the thing is done.

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# SPECIAL CORRESPONDENCE

## SCIENTIFIC WORK OF THE TENTH SOKOL FESTIVAL

THE Sokol is a national movement conceived in 1862 by Dr. Miroslav Tyrš, lecturer in the history of art at the Czech University in Prague, as a means of stimulating the cultural and political regeneration of the Czech people. Abroad it is recognized largely as a gymnastic organization, but behind the pageantry

[5] E. P. Lyon, *Amer. Jour. Physiol.*, 12: 149–161, 1904.

[6] C. Rutter, *Bull. U. S. Fish Com.*, 22: 65–141, 1902.

of its mass drills lies an almost unsurpassed example of what may be achieved in the way of scientific research through voluntary cooperative effort. The impetus given to the Sokol movement by Tyrš and Fügner almost a century ago has been continuously kept alive, for in its ranks, which numbered 800,000 before Munich, have stood some of Czecho-Slovakia's most distinguished men. From its very inception the Sokol and its history have been colored by the names of scientists. Dr. Eduard Grégr, Jan Evangelista Purkyně's assistant in the Prague Physiological Institute, contributed to the drafting of the association's first statutes.[1] He records that Tyrš attended Purkyně's lectures, and there are indications that this great, nineteenth century experimental physiologist influenced the formulation of a Czech physical education nomenclature and the selection of the Sokol's fundamental exercise program. The aged Purkyně himself took part in the physical activities of the Sokol, being one of a group of celebrated scholars of the university who trained under the direction of Malypetr. It is not strange, therefore, to find that from this heritage has grown an idea of service to the Sokol through science, which finds among its several outlets an admirable program of research pertaining to exercise.

Once every six years a Sokol Congress is held in which as many as 100,000 persons of both sexes participate, ranging in age from elementary school children to adults in the fourth and fifth decades. Medical examination is compulsory before entering into competition. Some of the events require great strength and neuromuscular skill, but the majority are adjusted to the capacities of average individuals in good health, accustomed to systematic exercise of a moderate type. The participants in the Pan-Sokol Festival are selected in preliminary district trials and thus probably represent the best physical specimens of the community at large. It is evident that the Sokol Slet offers a unique opportunity of assaying the physical status of a people and of studying innumerable problems in the physiology of exercise.[2]

At the instigation of medical research groups within the membership of the Sokol, a wooden building was constructed in 1932 to house rooms for scientific investigation and first aid during the ninth Slet. Since then the Ministries of Public Health and Physical Education, Public Works and Finance have erected an excellent research institute in the new northern wing added to the chief tribune of the Masaryk State Stadium at Strahov, Praha.[3] This included a series of rooms so arranged that large numbers of subjects might pass from one division of the examination to the next without interruption. Dressing rooms were so placed that either men or women might enter special units, such as the x-ray room. There was space for an electrocardiagram, a dark room, chemical laboratory and a surgical unit consisting of a preparation room, operating room and a sick room, the latter reserved for injuries or gynecological accidents too severe to permit the moving of patients to a hospital. The surgical unit was equipped without cost by Anýž and by Čížek. Its work was carried on by Professor Jirásek, chief of the First Surgical Clinic of Charles University, and the volunteer services of members of his medical and nursing staff. Vinopal loaned and installed without recompense two large x-ray units, the first of complete Czech make (Meta), and Foma contributed a fine grade of x-ray paper of Czech manufacture.

Early in the year all clinics were given an opportunity to submit projects for the tenth congress to a committee of the Sokol. This work was administered by Docent Jiří Král, Faculty of Medicine, Charles University, and a member of the League of Nations Committee of Experts on Physical Education. A brief résumé of the studies undertaken between May 29 and July 6, 1938, follows:

Dr. Klímová-Fügnerová, physician of the State Institute of Hygiene, and Dr. Záhoř examined the vision of Sokol children.[4] For those with acuity less than 5/10, ophthalmoscopic examination was provided. Dr. Klaus, of Professor Jerie's First Gynecological Clinic, Charles University, granted consultations to women participants in the upper age groups, studying the gynecological troubles appearing during the days of most strenuous exercise. Professor Ostrčil and his associates in the Second Gynecological Clinic, investigated the menstrual cycle of adolescent participants. Calendars were distributed, to be returned to the clinic after six months. His object was partly educational, that of teaching the young girl the importance and values of an accurate calendar record of the menstrual rhythm. At the previous Slet, Dr. Tillerová-Šebková had conducted an extensive interrogatory study to ascertain the influence of Sokol exercise upon child-bearing.[5] It had been suggested that labor is more difficult among those who participate in athletics. Professor Jirásek determined by x-ray and clinical examination the status of the joints of runners and the influence of their activity upon them.[6] Dr. šiška, member of the second surgical clinic Charles University under the direction of Professor Diviš, studied the feet of the same runners and

[1] J. Masák, *Tyršův Sborník*, 9, 1924.
[2] J. Král, *Věstník ČSl.Lékařů*, 50: 1030, 1938.
[3] M. Vejchoda-Ambros, *Ministry of Pub. Health and Phys. Ed.*, Praha, 1938.
[4] M. Klímová-Fügnerová, *Věstník ČSl.Lékařů*, 50: 1037, 1938.
[5] Z. Tillerová-Šebková, *Praktický Lékař*, 16: 175, 1936.
[6] A. Jirásek, *Věstník ČSl.Lékařů*, 50: 1032, 1938.

checked the condition of operated hernias among male participants.

Under the leadership of Dr. Račanský, chief orthopedic surgeon of the Bat'a Hospital at Zlin, 10 physicians from Zlin and 10 consultants from the clinics of Professor Zahradníček and Professor Frejka made foot measurements, plantograms and noted foot defects. They were assisted by 10 technicians from the Bat'a factory, who are normally employed as modelers for shoe lasts. Record cards in different colors lightened the work of separating the data accumulated on country and city children. The incidence of various foot defects in young people was studied, and those requiring medical attention were directed toward proper treatment. From the measurements and plantograms, the foot types of children will be determined and lasts constructed for shoes to fit these feet. Dr. Gellért, director of the Department of Internal Medicine of the Bat'a Hospital, investigated constitutional types among Sokol boys, studying in particular the relationship of habitus to foot defects, especially to flat feet. About 1,500 children were examined in this series of studies alone, and the work was entirely financed by the Bat'a factory.

Professor Hynek, chief of the First Clinic of Internal Medicine, Charles University, Docent Král and Dr. Baštecký made teleroentgenograms of the hearts of 500 Sokols. During the last Slet they had studied the post-exercise decrease in the size of the heart,[7] and had observed the frequency of mitral configuration in young adult men and women.[8] This year they added observations on adolescent boys and on men selected from amongst the oldest competitors. Electrocardiograms were also made on the latter group. It is Professor Hynek's ultimate plan to compare these large series of teleroentgenograms with observations on sedentary subjects, contributing to the still open question of the influence of exercise upon the heart. Professor Prusík, of the Propedeutic Clinic, commenced a study of syncope during the last Slet. Working with Professor Vondráček, the project was continued, making blood chemistry studies and observing the efficacy of the administration of salt as a preventative against fainting.[9]

The whole of this program was conceived and executed by Sokols. Professional services, furnishings, costly equipment and valuable supplies were voluntarily contributed. The actual research was conducted by experienced investigators under the leadership of men of the highest rank in the medical profession of Czecho-Slovakia, most of them connected with the Medical Faculty of the Czech University in Prague. All Sokols, familiar with the philosophical and practical aspects of this organization's exercise program, they were in a unique position to appreciate its problems, sense their importance and bring to bear upon them the fruits of a rich and varied scientific experience. Therein probably lies the motivating force behind the scientific work of the Tenth Sokol Festival.

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[7] J. Král and B. Polland, *Časopis Lékařů Českých*, 73: 541, 1934.

[8] K. Hynek, J. Baštecký and J. Král, *Cong. International de Méd. Appliqué a l'Éd. Phys. et aux Sports*, Chamonix-Mont Blanc, 1934.

[9] B. Prusík, *Věstník ČSl.Lékařů*, 50: 1033, 1938.

# SPECIAL ARTICLES

## THE EFFECT OF SEX HORMONES ON THE NORMAL RESISTANCE OF RATS TO CYSTICERCUS CRASSICOLLIS[1]

IT is generally recognized that sex is an important factor in the incidence and severity of certain diseases. Experimentally, this is especially apparent in working with controlled larval tapeworm (*Cysticercus crassicollis*) infections in rats where, in most cases, the degree of infection in normal females is only about 60 to 80 per cent. of that found in normal males.[2] That this sex difference is statistically significant is clearly shown by the investigations of Curtis, Bullock and Dunning.[3] In order to ascertain whether this sex difference could be altered by sex hormones, theelin and testosterone propionate[4] were injected into normal male and female rats, which were subsequently infected with a standardized dose of *Taenia taeniaformis* eggs.

A preliminary experiment carried out with the aid of Mr. I. G. Arnason suggested that the degree of infection might be altered under certain conditions by the injection of sex hormones. However, since the degree of the experimental infection was too low to afford adequate analysis, the work was repeated and the following more significant results were obtained which for the most part confirmed the earlier observations.

The animals were young adult virgin female and male albino rats weighing approximately 100 grams.

[1] This investigation was aided in part by the Mr. and Mrs. Frank G. Logan fund and in part by a grant from the Rockefeller Foundation to the University of Chicago.

[2] By personal correspondence, it has been learned from Dr. V. N. Moorthy, of the India Health Service, that a similar condition exists in human infection of *Dracunculus medinensis*. Under conditions in which males and females are equally exposed to infection, the disease is less prevalent in the latter.

[3] M. R. Curtis, W. F. Dunning and F. D. Bullock, *Am. Jour. Can.*, 17: 894, 1933.

[4] The theelin was supplied by Dr. Cartland, of the Upjohn Company, and the testosterone proprionate by Dr. Schwenk, of the Schering Corporation.

Methods used for determining the resistance of rats against infection with *C. crassicollis* have been previously described by the author.[5] Fifteen males and 15 females in one group were given 14 consecutive daily injections of 0.5 cc of sesame oil alone. Fifteen males and 15 females in a second group were given 14 consecutive daily injections of 0.5 cc sesame oil containing 0.005 mgm (5 International Esterogenic units) of theelin. A third group of 15 males and 15 females received 14 daily consecutive injections of 0.5 cc of sesame oil containing 0.6 mgm (equivalent to 40.2 International Androgenic units) of testosterone proprionate. All animals were inoculated at the time of the last injection. Seven weeks after infection the animals were sacrificed and the average number of parasites (cysts) determined by macroscopic examination of the livers. The average degree of infection in each group is given in Table 1. The normal sexual

TABLE 1

THE AVERAGE NUMBERS OF *Cysticercus crassicollis* FOUND IN NORMAL RATS AND IN RATS TREATED WITH EITHER THEELIN OR TESTOSTERONE PROPIONATE

| Group | Number of rats and sex | Treatment | Average number of cysts (± P.E.) |
|---|---|---|---|
| 1 | 15 males | Sesame oil | 62 (± 2.15) |
| | 15 females | | 42 (± 2.06) |
| 2 | 15 males | Theelin | 50 (± 2.49) |
| | 15 females | | 45 (± 1.62) |
| 3 | 15 males | Testosterone | 64 (± 1.97) |
| | 15 females | propionate | 60 (± 2.86) |

variation in resistance to infection is clearly brought out in Group 1. For example, the average infection of the control group of females was only 67 per cent. ($42 \times 100/62$) of that found in the control group of males (difference of $20 \pm 3.1$). The infection in females which received theelin was essentially the same as the untreated controls ($3 \pm 2.6$), but the males which received theelin showed a slightly lower degree of infection than the untreated control males ($12 \pm 3.2$). The theelin appeared to increase the resistance of males slightly, and the results probably would have been more pronounced had the animals been castrated. On the other hand, females which received male sex hormone showed a marked decrease in resistance to infection as compared to the normal females ($18 \pm 3.5$), which was approximately the same as that shown by the untreated control males, whereas males which received male sex hormones showed no change in resistance.

It appears, therefore, that the normal sexual variation in resistance of rats to *C. crassicollis* can be modified by the injection of sex hormone, but any explanation of such reactions must await further investigations on the physiological and cellular effects of such substances.

[5] Dan H. Campbell, *Jour. Immunol.*, 35: 195, 1938.

The author is particularly indebted to Professor F. C. Koch for his aid in this investigation.

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## THE ANTIDERMATOSIS VITAMIN REQUIRED FOR REPRODUCTION IN THE DOMESTIC FOWL

THE antidermatosis vitamin[1] is the water-soluble factor which prevents the dermatosis or pellagra-like syndrome of the chick, first described by Ringrose and Norris[2] and obtained in aggravated form on the Wisconsin heated diet.[3] Although dermatosis in chicks has been frequently observed in the experimental laboratory, no evidence that the mature fowl suffers from a deficiency of this vitamin has yet been reported. Hence a study of this problem was initiated, the results of which are presented in this report.

White Leghorn pullets were used as the experimental subjects in this study. The control group of pullets was fed the following diet, designated the normal diet:

| | Per cent. |
|---|---|
| Yellow corn meal | 40.65 |
| Wheat bran | 20.00 |
| Wheat flour middlings | 20.00 |
| Purified casein | 7.00 |
| Liver extract | 0.35 |
| Soybean oil | 5.00 |
| Wheat germ oil | 0.50 |
| Cod liver oil | 0.50 |
| Pulverized limestone | 3.50 |
| Steam bone meal | 2.00 |
| Iodized salt | 0.50 |
| Manganese carbonate | trace |

The remaining pullets were fed the same diet except that the cereal portion and the liver extract were heated in an oven for 36 hours at 120° C. in order to destroy the antidermatosis vitamin. This diet was designated the heated diet.

By proper attention to composition and through appropriate biological assays the heated diet was demonstrated to contain all the vitamins known to be required by the domestic fowl or not yet shown to be required, with the exception of the antidermatosis vitamin and the new growth and reproduction factor reported by Bauernfeind *et al.*[4,5] These are vitamins A, $B_1$, $B_4$, $B_6$, D, E, K, riboflavin (G), nicotinic acid and the antiencephalomalacia factor.

[1] Called filtrate factor by the California workers.

[2] L. C. Norris and A. T. Ringrose, SCIENCE, 71: 643, 1930.

[3] O. L. Kline, J. A. Keenan, C. A. Elvehjem and E. B. Hart, *Jour. Biol. Chem.*, 99: 295, 1932.

[4] J. C. Bauernfeind, A. E. Schumacher, A. Z. Hodson, L. C. Norris and G. F. Heuser, *Proc. Soc. Exp. Biol. and Med.*, 39: 108, 1938.

[5] J. C. Bauernfeind, A. E. Schumacher, A. Z. Hodson, L. C. Norris, and G. F. Heuser, *Poul. Sci.*, 17: 444, 1938.

The new growth and reproduction vitamin was added to the heated diet by means of a whey adsorbate and the antidermatosis vitamin by means of a rice bran concentrate.[6] This concentrate had been treated several times with fuller's earth to remove vitamin $B_1$, riboflavin and most of vitamin $B_6$. The concentrate was assayed in accordance with the procedure of Jukes and Lepkovsky[7] and found to have an antidermatosis value of 25.

At the start the hens were divided into two groups, one of which was fed the normal diet and the other of which was fed the heated diet in order to deplete the hens in this group of their reserves of the antidermatosis vitamin. This was determined by studying the hatchability of the eggs laid by this group. Weekly hatches were conducted during a depletion period of 7 weeks. The average hatchability of the eggs of the hens fed the normal diet during the depletion period was 63.9 per cent., while that of the hens fed the heated diet was 15.8 per cent. The hatchability of the latter group decreased to 2.7 per cent. during the depletion period. No improvement in the hatchability of this group was obtained by supplementing the heated diet first with 5 per cent. of the antidermatosis-vitamin concentrate and finally with 10 per cent.

Since it was recently found that the heated diet was also deficient in a new growth and reproduction factor, labile to dry heat treatment, the hens fed this diet were divided into three groups. One group was fed the heated diet as heretofore, a second group was fed the heated diet plus 5 per cent. of whey adsorbate containing the new factor, and a third group was fed the heated diet plus 5 per cent. of whey adsorbate and 5 per cent. of the antidermatosis vitamin concentrate. Their response in hatchability of eggs to these treatments was compared to that of the group of hens fed the normal diet. The results are presented in Table 1.

TABLE 1

HATCHABILITY RESULTS OBTAINED DURING THE EXPERIMENTAL PERIOD

| Pen | Number eggs set | Number hatches | Per cent. hatch |
|---|---|---|---|
| 1. Normal diet ..... | 232 | 6 | 60.0 |
| 2. Heated diet ..... | 115 | 6 | 2.8 |
| 3. Heated diet + 5 per cent. whey absorbate ..... | 139 | 6 | 3.3 |
| 4. Heated diet + 5 per cent. whey adsorbate + 5 per cent. antidermatosis vitamin concentrate ..... | 136 | 6 | 48.0 |

The average hatchability of the eggs of the hens fed the normal group was 60.0 per cent. during the experimental period, while that of the eggs of the hens fed the heated diet was 2.8 per cent. When 5 per cent. of whey adsorbate was added to the heated diet no improvement in hatchability was obtained over that on the heated diet. But when both 5 per cent. of whey adsorbate and 5 per cent. of antidermatosis vitamin concentrate were added to the heated diet the hatchability increased rapidly so that at the third hatch it was approximately equal to that of the hens fed the normal diet. The average hatchability of this group of hens during the experimental period was 48.0 per cent.

The hens were fed the heated diet for a period of 28 weeks without any macroscopic evidence of dermatosis developing and without any effect upon egg production or mortality. When a similar heated diet was fed to the chicks of normally fed hens, dermatosis did not develop until the chicks were 14 days of age. But when the chicks of hens nearly depleted of the antidermatosis vitamin were fed in a like manner, symptoms of dermatosis appeared at three to four days of age. This is evidence that the hens fed the heated diet deposited less of the antidermatosis vitamin in their eggs than the hens fed a normal diet.

It is concluded from the results presented in this report that the antidermatosis vitamin is required for hatchability or reproduction in the domestic fowl but that a lack of this vitamin did not affect egg production or mortality during the period represented by this experiment.

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## INDUCED PARTHENOCARPY OF WATERMELON, CUCUMBER AND PEPPER

PARTHENOCARPIC fruits, induced by means of hormones in lanolin paste, have been secured by Gustafson[1] in tomato, pepper, crookneck summer squash, Hubbard squash, eggplant and some ornamental plants. Several attempts were made to induce fruit set in watermelon and pumpkins, but failed. The result in cucumber was also discouraging.

Gardner and Marth[2] obtained parthenocarpic fruits in American holly and strawberry by spraying the pistillate flowers with different concentrations of hormones. Wong[3] in Florida found that indoleacetic and indole-propionic acids in lanolin paste did not induce parthenocarpic fruit, although parthenocarpy did exist in both seedless and seedy varieties of some common oranges in Florida.

While natural parthenocarpy commonly occurs in banana, Washington Navel and Valencia oranges,

[6] Prepared by Vitab Products, Emeryville, California.

[7] T. Jukes and S. Lepkovsky, *Jour. Biol. Chem.*, 114: 117, 1936.

[1] F. G. Gustafson, *Proc. Nat. Acad. Sci.*, 22: 628–36, 1936; *Am. Jour. Bot.*, 24: 102–7, 1937; *Bot. Gaz.*, 99: 840–4, 1938.

[2] F. E. Gardner and P. C. Marth, *Bot. Gaz.*, 99: 184–95, 1937.

[3] Cheong-yin Wong, unpublished data, 1937.

Marsh grapefruit, Sultanina graps and some Chinese persimmons it is rare in watermelon and American cucumber and has not been reported in peppers.[4,5]

An experiment was conducted by the writer during the summer of 1938 with the National Pickling variety of cucumber, in an attempt to secure seedless fruits with normal shape by means of growth-promoting substances. There were 8 series of experiments. All the treated blooms were covered with wire cages before anthesis as well as 4 to 6 days after treatment in order to avoid contamination. It was found that natural parthenocarpy occurs in this variety, but the occurrence is very rare. Naphthalene acetic acid caused parthenocarpic fruits either when applied in lanolin paste of 1 per cent. to 5 per cent. concentrations or as a 0.05 per cent. aqueous solution. The percentage of fruit set in hormone-treated flowers was higher than from self-pollination.

With watermelon, eleven varieties were used. Both indolebutylic and naphthalene acetic acids (NAA in short) were used. These were applied as 1.0, 2.5, and 5.0 per cent. concentration in lanolin paste and as a NAA 0.05 per cent. aqueous solution. Twelve different treatments were used. No parthenocarpic fruits were formed except from blossoms treated with NAA. Fruits were induced to set by treating the cut style in all concentrations of lanolin paste and possibly in aqueous solution. Hormone-treated watermelons were perfectly seedless but varied in fruit shape. In general, the hormone-treated fruits were more or less triangular in shape, some even resembling the Table Queen squash rather than watermelon. Some, however, were normal in shape and size. The texture of these fruits was very solid and firm. No differences in flavor could be detected from normally pollinated fruits.

The seed of three plants of the Winter Sweet watermelon had been subjected to colchocine treatment before planting. The plants showed a typical colchicine effect, *i.e.*, stunting early in the season, large size of leaves and flowers and great vigor later in the season. Although pollen was present in great abundance, it failed to induce fruit setting when the blossoms were selfed. On the other hand, hormone-treated flowers set very satisfactorily. Fruits were formed in some open-pollinated flowers (with plenty of seeds), probably due to fertilization from nearby normal plants (vicinism).

Very satisfactory results were obtained in pepper of the Harris Wonder variety, both by using 1 per cent. of NAA in lanolin and spraying with 0.05 per cent. aqueous solution.

A detailed report will be published elsewhere in the near future.

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## SHORTENING DAYLIGHT PERIODS BETWEEN MAY 15 AND SEPTEMBER 12 AND THE PELT CYCLE OF THE MINK[1]

ONE of us[2] found that the pelt cycle of the ferret (*Putorius vulgaris*) is conditioned by length of day in correlation with the sexual cycle under the control of the hypophysis. This cycle was controlled and modified by manipulating the daily period of light to which the animals were exposed.

In a rather crudely and irregularly carried out experiment last summer, mink (*Lutreola vison*) were used as experimental animals, to see if this nearly related animal was responsive in the same way. The experiment was carried out in a cellar, where the temperature was not controlled and varied with the season but within somewhat narrower limits than that outside in the full light of day.

Controls consisted of about fifty mink of both sexes kept in the usual type of pen outside in the daylight and fed and cared for in the usual way. Some had distemper and some had not. Experimental animals consisted of four males and twelve females kept in the cellar in cages similar to those of controls. None of them had the distemper and all remained in good health and condition throughout the experiment. They were introduced into the cellar at four different times between May 15 and June 16.

By closing light-tight shutters over the two windows of the cellar, the light-time each day was gradually reduced from May 15 to June 23; increased gradually until July 26, because nothing seemed to be happening to the first animals introduced. It was then gradually reduced again until September 12. This second reduction was given because on July 26 it was noted that three of the animals (2 ♂ ♂ + 1 ♀) were in the condition of fur normal for the first week of October. They were shedding summer pelt and growing winter pelt from the tails forward. All experimental animals were removed from the cellar and returned to normal daylight on October 24. For two weeks, beginning on August 22, one male and one female that seemed to be slow to change pelt were placed in a refrigerator for from one-half to two hours each second day to see if

[4] H. A. Jones and J. T. Rosa, "Truck Crop Plants," p. 437, 1928.

[5] R. Wellington and L. R. Hawthorne, *Am. Soc. Hort. Sci. Proc.*, 25: 97–100, 1929.

[1] Aided by grants from the National Research Council, Committee for Research in Problems of Sex, 1937–38, and the Penrose Fund of the American Philosophical Society, 1938–39, administered by T. H. Bissonnette.

[2] T. H. Bissonnette, *Anat. Rec.*, 63 (2): 159–168, 1935; *Quart. Rev. Biol.*, 11 (4): 371–386, 1936; *Endocrinology*, 22 (1): 92–103, 1938.

reducing temperature would hasten their reaction or improve their winter pelts. All animals were fed the usual summer diet of red meat (until September 15).

Controls put on winter prime pelts at the usual time in October and early November or later, whether they had distemper or not.

Six of the experimentals reached normal winter prime pelt before September 18, except for slight reddish color due to the red meat diet: one female before August 17, the hottest of summer time; two others before September 1 and 6; two males before September 12 and one before the 18th. Another female barely failed to complete prime coat before September 12 and two others (♂ + ♀) loosened summer fur but failed to grow winter pelt except on the tail. Refrigeration may perhaps have helped one male slightly toward prime coat; but it was completely ineffective with the female similarly treated.

Other experimental females failed to show any change of pelt except to have a few hairs become loose in September and October and failed to assume prime winter pelt even at the usual time before November 7. They were apparently rather drastically upset by the irregular changes in length of day just about the time they were beginning to become responsive.

It is, therefore, indicated that the assumption of winter prime pelt by mink may be induced in summer in spite of relatively high temperatures or hastened in autumn by reducing the duration of the periods of light (and/or its intensity) to which the animals are exposed daily. Reduced temperature is, apparently, at most, a minor factor in this reaction.

The complete experiment will be described in detail elsewhere.

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# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## A GLASS AND RUBBER LABORATORY PUMP

THE pump to be described here is a modification of one designed by Palmer.[1] Like Palmer's, it is operated by compressed air, and the fluid being pumped is in contact with glass and rubber only. It has the added advantages of greater capacity—1,500 cc per minute against a pressure of over a meter has been attained—and of operating in any position.

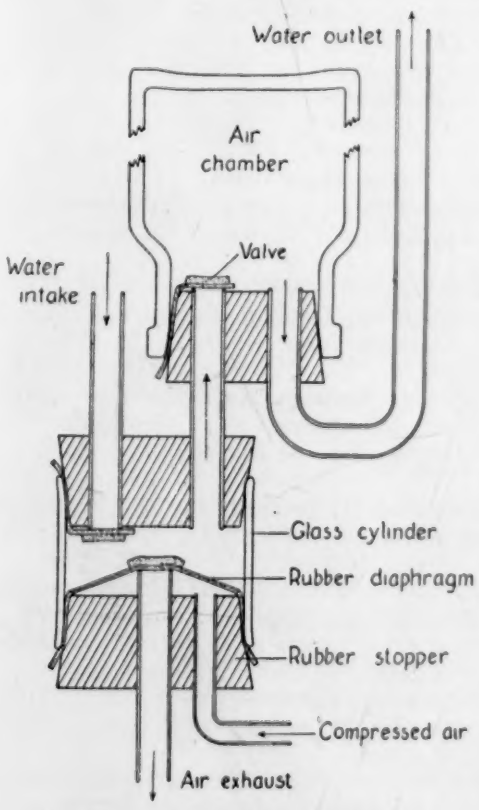


FIG. 1. Section of pump.

[1] J. Palmer, SCIENCE, 80: 229–230, 1934.

The construction is shown in Fig. 1. The cylinder is made of a piece of Pyrex tubing with an internal diameter of two inches. Considerable strength is necessary, but for pumps built on a smaller scale Pyrex need not be used. The diaphragm and valves are of rubber dam about 1/40 inch thick. They must not be stretched too tightly. *Ecru* dam should be used; the "buckskin" rubber dam popular with dentists fails after two or three weeks. The life of these parts is increased by attaching with rubber cement a small piece of rubber (*e.g.*, inner tube) to the diaphragm and to each valve, as shown in the figure. The ends of the tubes over which the valves and diaphragm fit should be ground to an even rim and fire polished. All stoppers must be wired in place.

A head of water (or of whatever fluid is to be pumped) is necessary at the intake. This fills the cylinder, pressing down on the diaphragm, and passes up through the air chamber and outlet tube to a height equaling the head at the intake. When the compressed air is turned on, the diaphragm is lifted, closing the intake valve and driving the water through the outlet, but the weight of the water, opposed only by atmospheric pressure in the exhaust, holds the diaphragm against the end of the exhaust for some time. Finally, the increasing pressure below the diaphragm lifts it off the exhaust, allowing the air to escape and the diaphragm to fall. As it falls, the cylinder is refilled through the intake, the exhaust is closed, and the process starts again. Each cycle moves only three or four cubic centimeters of water, but the pump operates at about six strokes per second. The flow of compressed air must be carefully adjusted by a clamp close to the

pump to achieve the maximum rate of pumping; too rapid flow will cause the diaphragm to buzz without accomplishing anything. The pump is sometimes temperamental about starting. Very often the trouble can be traced to faulty construction, but it is also true that valves and diaphragm improve after they have been in place for a time. Once started, the pump will run for weeks without attention. Sometimes the air is slowly absorbed from the air chamber and must be replaced. This can be done by blowing air through the intake. The pump will work in any position, but the air chamber must be more or less vertical with the stopper down.

High efficiency depends chiefly upon well-fitting valves and rapid inflow. As many as four parallel intake tubes have been put in with very satisfactory results. The writer has for the most part used the pump simply submerged in the barrel of sea water that was being circulated. The exhaust tube was, of course, extended to a point above the surface of the water.

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## AN INEXPENSIVE WARM STAGE

A WARM stage is a very useful addition to the microscope, particularly for such investigations as the demonstration of motile amoebae in stools. Where only an occasional examination is made, the cost ($15 to $20) is likely to be prohibitive.

A very serviceable stage can be made at a trivial cost from an electric iron heating element. This comes copper clad and slotted as shown in the drawing. It draws 550 watts at 110 volts, becoming red hot. However, if it is connected to the secondary terminals of a

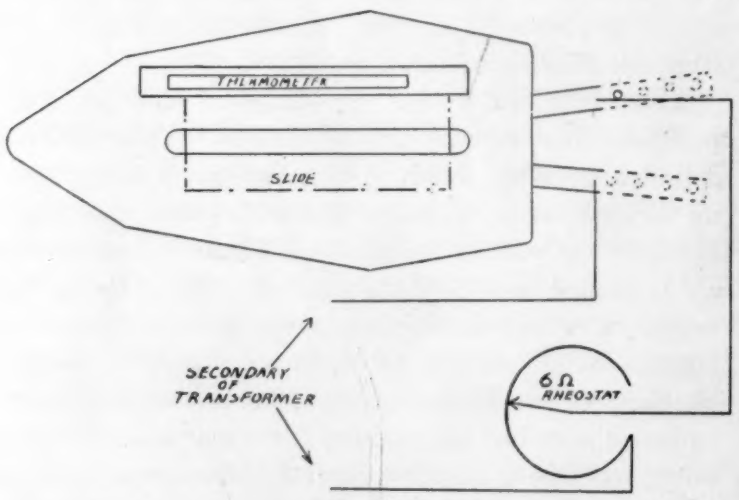


FIG. 1

bell-ringing transformer, it does not take much current and rises to a temperature of 40° C. or less. By connecting a 6-ohm radio rheostat in series, the current can be regulated so as to maintain a temperature of 37° C.

The construction is quite simple. With a hack-saw or grindstone, remove most of the side of a piece of ½" pipe about 3½" long, leaving both ends. This furnishes the thermometer carrier. The slot enables the operator to read the temperature. Lay the element on a piece of asbestos and connect the terminals to the 110-volt mains. The element becomes quite hot in a few seconds. Place a strip of solder about ½" from the slot. Place the pipe on the molten solder and disconnect the electric current. When cool, the pipe will be firmly fastened to the element. Cut off the portion of the element terminals shown in dotted lines and solder wires to them. Connect these wires to the transformer through the rheostat.

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